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PHO-TR515

CR - 128843
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Display Formats Manual

Contract NAS 9-1261

12 JANUARY 1973

prepared for

National Aeronautics and Space Administration

Manned Spacecraft Center

(NASA-CR-128843) DISPLAY FORMATS MANUAL
(Philco-Ford Corp.) 167 p HC \$10.50

CSCL 09B

⁰N73-19228

Unclas
G3/08 65523

PHILCO 

Philco-Ford Corporation
Houston Operations

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DISPLAY FORMATS MANUAL

CONTRACT NAS 9-1261

Submitted to the
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MANNED SPACECRAFT CENTER
Houston, Texas

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FOREWORD

This document, PHO-TR515, is prepared in accordance with the requirements of Schedule IV of Contract NAS 9-1261, Modification No. 114, Exhibit A, Statement of Work, Paragraph 3.0, as ammended.

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SECTION 1

INTRODUCTION

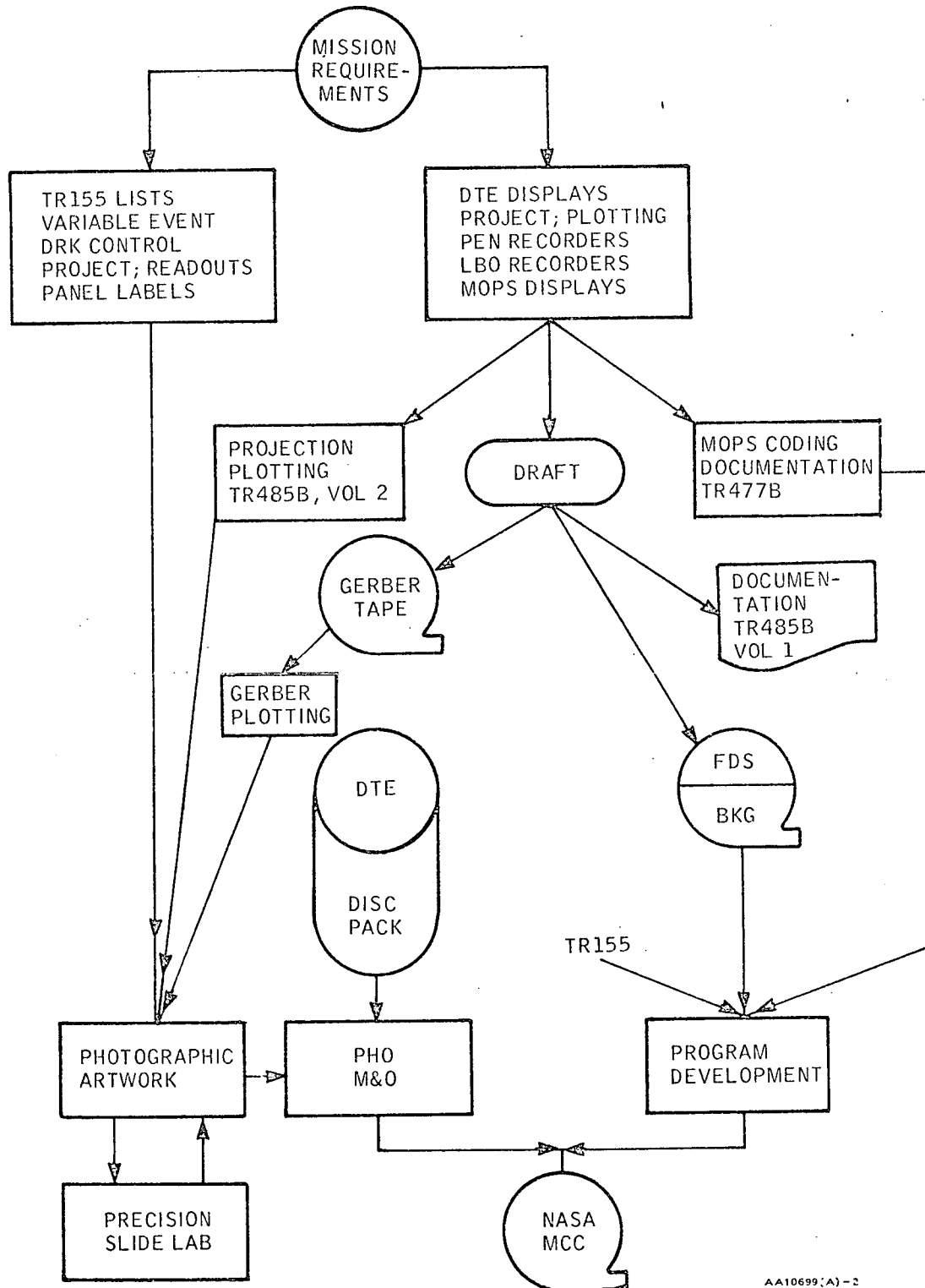
1.1 PURPOSE

This manual outlines the standards and procedures for the generation of operational display formats to be used in the Mission Control Center (MCC) display control system. It identifies, explains, and catalogs the required effort, forms, and fundamentals for the design, specification, and production of display formats. It also explains the principles of display design and system constraints controlling the creation of optimum operational displays for mission control.

1.2 MCC DISPLAY FORMATS

The MCC display systems present information from two types of sources. The first, static or background data, is prepared photographically or is stored on magnetic tapes or discs. The second, dynamic data, is real-time data controlled and routed to the display devices by computer programs. During operation, corresponding sets of static and dynamic data are presented together to form the complete display. Static information consists of lines, labels, titles, etc., that will remain the same as long as a display is used. Dynamic information consists of the information that will change during operation. An example of this type of information is the analog values of temperatures, velocities, and pressures or the lighting of color coded labels for discrete changes. The general procedures for initiating and producing a display are described in the following paragraphs and are illustrated in Figure 1-1.

- A. When a display system user determines that mission operations requires use of a particular type of display format, he contacts the Philco Display Design Section or the Philco Requirements and Configuration Section.
- B. The Requirements and Configuration Section gathers data via data pack circulation and prepares (with computer listings) PHO-TR155, *Configuration and Control Document*. Preliminary



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Figure 1-1 MCC Display Formats

listings serve as inputs for production of photographic display items by the Display Design Section. Concurrent listings serve as inputs to RTCC program tables controlling the light indications. Included are variable event panel overlays, DRK control panel button reticles, projection readout reticles, and numerous panel labels.

- C. The Display Design Section engineer coordinates with the flight controller or other users in developing optimum display formats for DTE displays, projection plotting displays, pen recorder overlays, and light beam oscillograph overlays. Display coding and documentation support are also provided for the Mission Operations Support System (MOPS).
- D. Detailed projection plotting display specifications are developed and published in PHO-TR485B, Volume 2. These serve as input for photographic production of the artwork for precision etched slides.
- E. DTE displays and recorder overlays are designed on the DRAFT system. Output end items include printer listings, display screen hardcopies, magnetic tapes, and disc packs. Documentation is provided in PHO-TR485B, Volume 1.
- F. The RTCC background tape includes the complete background data for each DTE display formatted in DTE computer language. The FDS tape includes the dynamic data configuration and source for each parameter or each display. Together, these two tapes define a DTE display to the RTCC programs.
- G. The DTE disc packs are produced by off-line programs on the IBM 360/44 computer. They contain diagnostic displays, character fonts, and tables necessary to the DTE operation.
- H. The Gerber tape output for recorder overlays contains numerical control commands for operating the Gerber plotter.
- I. Using appropriate scaling factors, the Gerber plotter with optical exposure head produces positive film chips for recorder overlays.

- J. The Display Design Section produces photographic artworks from PHO-TR155 listings, projection plotting specifications, and Gerber film positives. DRK and projection readout artwork is forwarded to the Technicolor precision slide lab for completion and return of reticles. Projection plotting mylar matte artwork is forwarded to the slide lab for etched slide production and return. All other artwork is completed in-house.
- K. Completed reticles, overlays, slides, and mission disc packs are delivered to Philco M&O for installation in the MCC.
- L. IBM develops the programs supplying the dynamic inputs to the MCC from the background tape, FDS tape, and PHO-TR155 listings.
- M. NASA utilizes the operational displays for mission monitoring and control.

1.3 REFERENCES

The following documents shall be referenced for future information.

MSFC-STD-267A	<i>Human Engineering Design Criteria</i>
MIL-STD-1472A	<i>Human Engineering Design Criteria for Military Systems, Equipment, and Facilities</i>
AFSCM-80-3	<i>Handbook of Instructions for Aerospace Personnel Subsystem Design</i>
WDL-TR-E120	<i>Considerations of Available Display Hardware, Appendix 5A</i>
USGPO	<i>Style Manual</i>
SP-08873A	<i>Digital Television Equipment Procurement Specification</i>
PHO-TR446	<i>DTE Background Disc Recording Program Requirements</i>
PHO-TR503A	<i>DTE Character Font Designs</i>
PHO-TR409	<i>Program Requirements for the DRAFT II System</i>
IBM NAS 9-996	<i>Display Retrieval and Formatting Technique (DRAFT) II</i>
SE-09467	<i>DRAFT Display/Control System Performance Specification</i>
PHO-TR485A	<i>Skylab Mission Program Requirements for the RTCC</i>
PHO-TR485B	<i>Skylab Display Formats Specifications</i>
PHO-TR477A	<i>MOPS Requirements</i>
PHO-TR477B	<i>Mission Operations Planning System (MOPS) Display Format Specification</i>
PHO-TR407B	<i>ALSEP Operational Display Formats</i>

SECTION 2.

DISPLAY DESIGN

2.1 DEFINITIONS

A display is a pattern of sensory cues, usually visual or auditory, arranged and presented in a meaningful fashion to provide information concerning the functioning of the system or any of its parts.

Display systems are combinations of items such as cathode ray tubes, plotters, trans-illuminated indicators, labels, dials, printers, and their supporting electronic circuits and interfaces.

A display format is a particular pattern or arrangement of data to be displayed.

2.2 TYPES OF VISUAL CODING

Visual codes should be selected so as to reduce search and location time. In general, location time is less for color coding and increases for shape, brightness, and size coding, in that order.

- A. Color Coding. Table 2-1 presents the standard meanings for color. Additional colors may be used to provide aid in visual search. The same color should be applied to related data or functions. It must be assured that color can be discriminated by the user population and that color will be distinguishable under conditions of high and low ambient illumination.
- B. Shape Coding. Combinations of letters and numbers are restricted by space requirements and the user's ability to learn their meanings. If used, alphanumerics must be in an upright orientation, have sharp outlines, high contrast, and be well lighted. Geometric shapes should be chosen which are compatible with, and have associations with, the coded objects and can be correctly identified with nearly 100 percent accuracy.

TABLE 2-1
COLOR CODING

COLOR	OPERATOR RESPONSE	MEANING
IDENTIFICATION RED	OPERATOR SHOULD ADOPT SOME ABNORMAL PROCEDURE OR INITIATE REMEDIAL EMERGENCY ACTION IMMEDIATE ACTION RE- QUIRED	DANGER KILLER WARNING (PER- SONNEL OR EQUIPMENT) MASTER SUMMATION (SYS- TEM OR SUBSYSTEM) MALFUNCTION, ACTION, STOPPED, FAILURE, STOP ACTION
IDENTIFICATION AMBER YELLOW	OPERATOR SHOULD MONITOR IN PREPARATION TO ADOPT- ING AN ABNORMAL PRO- CEDURE OR REMEDIAL ACTION (IMMEDIATE AC- TION MAY BE NECESSARY)	EXTREME CAUTION (IM- PENDING DANGER) TECHNICAL HOLD OR CON- TROLLED TEMPORARY INTERRUPTION
IDENTIFICATION GREEN	OPERATOR SHOULD CONTINUE NORMAL MONITORING AND/ OR NORMAL OPERATING PROCEDURES	MASTER SUMMATION (SYS- TEM OR SUBSYSTEM) GO AHEAD, IN TOLERANCE ACCEPTABLE, READY, NORMAL
IDENTIFICATION LUNAR-WHITE	AWARENESS OF FUNCTIONAL CONDITIONS NO ACTION REQUIRED	FUNCTION, PHYSICAL POSITION, OR ACTION IN PROGRESS

- C. Brightness Coding. Under good viewing conditions, no more than four brightness levels can be used. Two levels are preferred: bright and dim, or light and dark.
- D. Size Coding. Symbol size may be correlated with an actual characteristic of the coded object, e.g., importance or range.

2.3 WARNING SIGNALS

Special displays shall not be unnecessarily distracting; e.g., warning signals shall not be distracting any longer than is necessary to attract attention and apply corrective action. The flash rate for flashing warning lights shall be from 3 to 5 flashes per second, with the time they are on being equal to the time they are off. Audio signals should be provided as necessary to warn personnel of impending danger, to alert an operator to a critical change in system or equipment status, and to remind an operator of a critical action to be taken.

2.4 UNIVERSAL FORMATTING CRITERIA

The following criteria apply to all types of display formats.

- A. Displays shall be easily and quickly read for quantitative, qualitative, or status information.
- B. Displays shall provide all necessary discrimination and interpolation and shall be free of unnecessary information that may unduly complicate the reading.
- C. Displays shall provide true indication of component status.
- D. Displays shall have labels and units of measurement that are as brief as possible, but fully comprehensible to the operator.
- E. Layout of displays shall be logical and systematic, e.g., subsystem status should be arranged in a logical pattern so as to permit the operator to become informed by a quick scanning.
- F. Display entries shall be labeled in terms of the function or event that is being monitored or controlled, not in terms of the control or display name.
- G. Display of non-normal information should not be unnecessarily distracting, e.g., warning signals shall not be distracting any longer than is necessary to attract attention and to apply corrective action.

- H. Data which changes frequently (dynamic data, real-time data, message data) should be easily and separately discriminable from unchanging data (static data, background data).
- I. High data density significantly affects the scanning and recognition time of individual parameters. White or empty space may be used to decrease the recognition time.

2.5 DETAILED FORMATTING CRITERIA

2.5.1 General

The following detailed criteria for various display types provide general guidelines for usage. Exceptions are permissible but should be carefully coordinated for acceptability to all potential users.

2.5.2 Group Displays

- A. The minimum letter size should subtend 10 minutes of arc in height to the farthest observer; 15 minutes of arc is optimum. For example, at a viewing distance of 80 feet, the minimum letter size would be 2.8 inches in height. Width-to-height ratio should be 3:4, and stroke width ratio should be 12:1.
- B. Space between lines should not be less than one-half nor more than one letter height; and space between letters should be approximately one-eighth of the letter height.
- C. Margins around the edge of the display should not be less than one-half the letter width, and not more than the width of one letter space.
- D. The minimum ratio of brightness between the object observed and surrounding ambient illumination is 6:1. Maximum display brightness should not exceed 35-foot lamberts.

2.5.3 Plotters

- A. Plotting points and trace shall be readily visible and not obstructed by the pen assembly or arm.
- B. A minimum of 50 percent contrast shall be provided between the plotted function and its immediate background.
- C. Aids, such as graphic overlays, shall be provided when the user is required to interpret graphic data. Such aids should not obscure or distort the data.

- D. Where applicable, plotters shall be mounted so that plotted information may be annotated while still in the plotter.

2.5.4 CRT Displays

2.5.4.1 Tabular Formats

Figure 2-1 illustrates the following criteria for tabular formats.

- A. Spacing. A minimum of one-half character height above and below each horizontal line and at least one character space from vertical line on the right.
- B. Stubheading. Centered in box the length of longest column heading box.
- C. Column Heading. Centered above column.
- D. Spanner Heading. Centered above two or more columns (also applies to subspanner heading).
- E. Center Heading. All capital letters and centered over description in table stub.
- F. Flush Heading. Flush entries over subordinate items are followed by a colon.
- G. Subentries. Indented two spaces.
- H. Overruns. The second line of column headings or data descriptions are indented one space.
- I. Dashes. Inserted at the end of data description in table stub and carried through all figure columns whose entry is blank.
- J. Column Numbers. Set in parentheses and centered under column heading.

TABLE HEADING

STUBHEADING	SPANNER HEADING				
	COLUMN HEADING (1)	COLUMN HEADING (2)	COLUMN HEADING (3)	SUB-SPANNER HEADING	
				COLUMN HEADING (4)	COLUMN HEADING (5)
CENTER HEADING	SUB-COLUMN HEADING XXX XXX XXXX	SUB-COLUMN HEADING XXX XXX XXXX	SUB-COLUMN HEADING XXX XXX XXXX	SUB-COLUMN HEADING XXX XXX XXXX	SUB-COLUMN HEADING XXX XXX XXXX
SUBENTRY HEADING: DESCRIPTION----- DESCRIPTION-----					
TOTAL -----					

Figure 2-1 Tabular Formatting;

- K. Parallel Columns. If data in the table stub is carried over to the second part of a double table, the center heading or flush heading followed by "continued" is inserted at the top of the stub.
- L. Numerical Columns. Numbers align on the right. Plus or minus signs at the left of numbers are placed next to the numbers, disregarding alignment. Double rows of numbers in a single column connected by a dash, a plus or minus sign, or a word, have the connectors aligned. Decimal points are aligned except in columns containing mixed units. All total, mean, or average subentries are indented three spaces within the table stubs.
- M. Symbol Columns. Columns consisting of letters, alphanumerics, symbols, and/or signs should be aligned on the left.
- N. Letter Sizes. The smallest value of symbol resolution required for both 525-line and 945-line television systems is 10 active lines per symbol height.

2.5.4.2 Graphic and Scale Formats

The following paragraphs define the criteria for graphic and scale formats.

- A. Numerical Progression Scale. Table 2-2 illustrates good, fair, and unacceptable progressions.
- B. Grid Lines. Grid lines may be omitted on small graphs if plotting points can be accurately read. In most cases, it is desirable to use only major divisions of the grid to reduce display clutter. If more divisions are required, construct graphs so that number (major) grids are bolder than unnumbered (minor) grids. If 10-grid intervals are used, the fifth intermediate grid is less bold than the numbered grid, but bolder than the other unnumbered grids. Grid lines are broken around any printed legends within the graph.

TABLE 2-2
SCALE NUMERICAL PROGRESSION

GOOD					FAIR					NOT ACCEPTABLE			
1	2	3	4	5	2	4	6	8	10	0	2.5	5	7.5
5	10	15	20	25	20	40	60	80	100	4	8	12	16
10	20	30	40	50	200	400	600	800	1000	0	15	30	45
50	100	150	200	250						30	60	90	120
100	200	300	400	500						0	60	120	180

- C. Plotting Points. Actual data points should be indicated by circles, triangles, or squares.
- D. Discrimination of Curves. When more than two classes of data are shown on a single graph, the points may be differentiated by using open and filled data points, and by connecting lines of small dots, long and short dashes, dots and dashes, or strings of symbols.
- E. Lettering. The following conventions shall be used for lettering.
 - All numbering or lettering of grid points on horizontal and vertical axes should be horizontal.
 - The legend for the horizontal and vertical axes should be horizontal.
 - The legend for the horizontal scale should be parallel with that axis.
 - The legend for the vertical axis should be lettered along a vertical line parallel with that axis.
 - Internal legends should be placed in the upper or lower right corners.
 - When only two classes of data appear in the graph, legends may be inserted in close proximity to the referenced curve.

2.5.5 Indicator Legends

The following conventions shall be used for indicator legends.

- A. Markings on legend plates shall be a minimum of 0.12 inch in height. Width of letters should preferably be $\frac{3}{5}$ of the height. Stroke width should be $\frac{1}{7}$ to $\frac{1}{8}$ of the height.

- B. Lettering shall be all capitals and gothic in style.
- C. Minimum space between characters shall be one stroke width. Minimum space between words shall be one character width.
- D. Only horizontal lettering shall be used, and the number of lines per legend plate shall not exceed three.

2.5.6 Labels

The following conventions shall be used for labels.

- A. Labels shall be read horizontally and be oriented to read from left to right.
- B. Spacing between words shall be one letter width; spacing between two lines of lettering shall be a minimum of 75 percent of letter height.
- C. Styles of letters shall be simple and unadorned. Upper case letters shall be used.
- D. Arabic numerals shall be preferred over Roman numerals.
- E. Letters shall be black on a light background (preferred) or white on a dark background.
- F. Size of label depends on its functional use. Table 2-3 lists the minimum character size for panel labels.
- G. Flags shall be used to display qualitative, non-emergency conditions.

2-12

TABLE 2-3
PANEL LABEL SIZE

PURPOSE	NOMINAL HEIGHT	NOMINAL WIDTH
PANEL TITLE	$1/4 \pm 1/64$ INCH	ALL 3:5 RATIO TO HEIGHT
SUBDIVISION OR FUNCTIONAL GROUP TITLE	$3/16 \pm 1/64$ INCH	
POSITION OF CONTROL AND SINGLE CONTROL TITLE	$1/8 \pm 1/64$ INCH	
LEGEND AND LIGHT INDICATOR	$1/8 \pm 1/64$ INCH	

SECTION 3

DTE DISPLAY FORMATS

3.1 INTRODUCTION

The digital television equipment (DTE) system is the primary display system in the MCC. It operates under program control to route and display real-time spacecraft and tracking network data on flight controller consoles.

Displays are formatted to present data in the form of graph plots, tables, and schematics.

The display retrieval and formatting technique (DRAFT) system is used for design and storage of displays. Output end items from the DRAFT system consist of printer listings, magnetic tapes, and television monitor hardcopies.

Documentation of displays consists of publishing the monitor hardcopies and the descriptive listings.

3.2 ORGANIZATIONAL INTERFACES3.2.1 General

The operational steps and organizational interfaces occurring during design, approval, documentation, and delivery of DTE display formats are diagrammed sequentially in Figure 3-1. There are three deliverable items.

- A. RTCC Background Tape. This tape carries the background data formatted in DTE computer language words.
- B. FDS Tape. This tape carries the dynamic data configuration code and descriptive data as to source and display coordinate destination of each parameter.
- C. DTE Disc Pack. The mission disc pack is an integral part of the DTE display system. It provides the necessary fonts, data tables, and test displays necessary to the operation of the DTE display system.

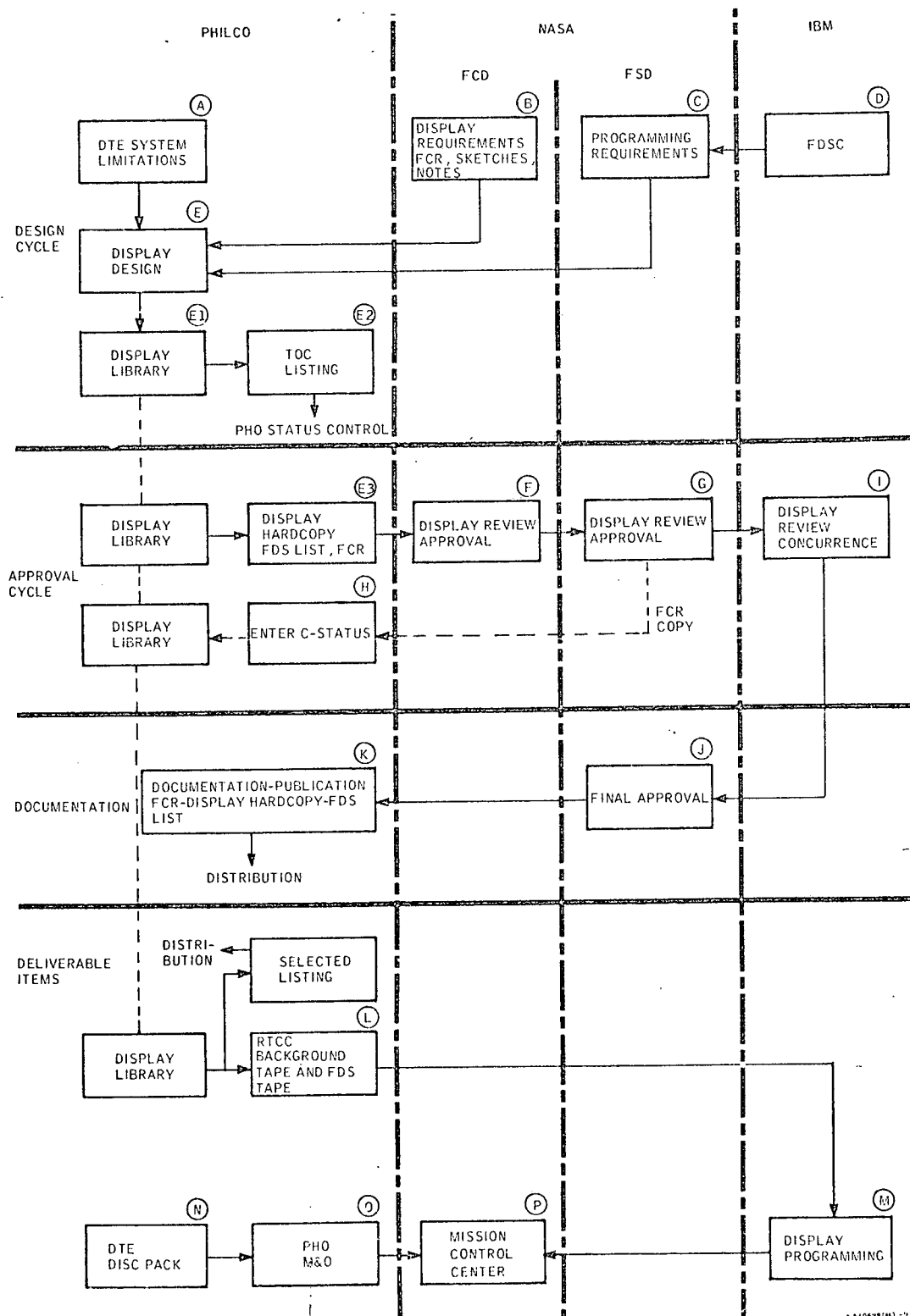


Figure 3-1 DTE Display Format Organizational Interfaces

3.2.2 Interface Description

Circled letters in Figure 3-1 refer to the following.

- A. The DTE display control system has certain inherent characteristics which must be considered during display format design. Some of these are character size, number of alphanumeric characters per line, number of alphanumeric lines per page, and spacing.
- B. The request for a new or changed display is made on a format change request (FCR) form and forwarded to Philco-Ford Display Design. The flight controller requesting a display furnishes the display design engineer with notes, sketches, and other technical data needed for the display.
- C. The mission program requirements for the RTCC provide data on overall programming requirements and limitations.
- D. The FDSC is originated by IBM to flag program corrections or changes. The FSD Data Processing Branch forwards such valid changes and corrections to PHO for FCR implementation and coordination.
- E. Using DRAFT, the display design engineer produces a display in accordance with the above inputs. The following events occur:
 - 1. During design of the display, a permanent record, the display library, is created which contains the complete display (background and dynamic data) plus the additional descriptive data needed for programming the display.
 - 2. Table of contents (TOC) listings are obtained for PHO status control and monitoring purposes.
 - 3. A hardcopy of the display is produced which shows both background and dynamic data. A printer listing (FDS) is also made which describes the dynamic data configuration, source, and display coordinate destination.

- F. The flight controller reviews the hardcopy and FDS and signs the FCR indicating approval. If he wishes, he may view the display on the DRAFT console.
- G. The cognizant Data Processing Branch engineer reviews the hardcopy and the FDS to assure their agreement with program requirements. Approval at this point authorizes placing the display in C status to enable inclusion in the background tape, FDS tape, and DTE mission disc pack.
- H. The display engineer receives a copy of the approved FCR (see Figure 3-2) and enters a C in the display TOC status area.
- I. The hardcopy and printout are forwarded by the Data Processing Branch technical monitor to IBM for their concurrence.
- J. After IBM concurrence is obtained on the FCR, the Data Processing Branch approves the display for final documentation.
- K. The display format documentation consists of the approved FCR, FDS, and DSH. It is approved by Philco-Ford, and distribution is made in the appropriate technical reports.
- L. The display background data and FDS data are placed on tape periodically and forwarded to IBM. The two tape outputs are limited to C status displays. Modification or change after tape delivery requires an FCR.
- M. Using the RTCC background and FDS tapes, IBM accomplishes the display system programming.
- N. The required number of mission disc packs is produced off-line on the 360/44. Delivery is made to Philco M&O.
- O. Philco-Ford M&O personnel load the DTE disc pack in the DTE display system.
- P. The prime user of the display in the MCC is the Flight Control Division.

"C" STATUS JUSTIFICATION
DATE: _____
BY: _____

FCR NO. _____

FORMAT CHANGE REQUEST

OLD FCN _____ OLD PCL _____ NEW FCN _____ NEW PCL _____
 MSK _____ FLT NO. _____
 TITLE _____
 ORIGINATOR _____ EXT _____ BRANCH _____ DATE _____

CHANGE REQUEST

REASON FOR CHANGE

PROGRAMMING CONTENTS

APPROVED: (ORIGINATOR) _____ DATE _____
 (FCD BRANCH CHIEF) _____ DATE _____
 (FCD APPROVAL) _____ DATE _____
 (COGNIZANT DPB) _____ DATE _____
 (IBM) _____ DATE _____
 (DPB CHIEF) _____ DATE _____
 (DFD/PHO) _____ DATE _____

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Figure 3-2 Format Change Request

3.3 EQUIPMENT OPERATION

The DTE cluster accepts and processes into a digital television display the computer language data words from the RTCC or from the cluster resident disc pack. Figure 3-3 illustrates major functional units.

Inputs from the RTCC go into eight channel buffers. The RTCC data is designated as either dynamic or background by the preceding D/TV command word. If the RTCC data is specified as background, it is loaded into the correct dynamic data buffer, processed through the C/V generator and DL core memory and into the background RM buffer. If it is dynamic data, it follows the same route but goes into one of the dynamic data buffers.

The internal disc pack contains diagnostic test displays and tables used within the DTE cluster. The disc pack originated display data is read into the single background buffer on receipt of a CSF command word. The data processing unit cycles through the data words in each buffer converting them with the character/vector generator and storing them in the display language (DL) memory core. The character/vector generator identifies the words as either character or vector words. Vector word direction, slope, and length are determined and written into the DL core memory. Character words cause the C/V generator to access the character font library in the DL core area and copy the character into the DL core.

The DL core memory stores a complete visible display field of either dynamic or static information prior to its transfer to the refresh memory core.

Each of the eight channels has a separate background and dynamic refresh memory core. The two are *OR*'ed together into one video output and then routed by the VSM to the console and monitor specified in the CSF command word.

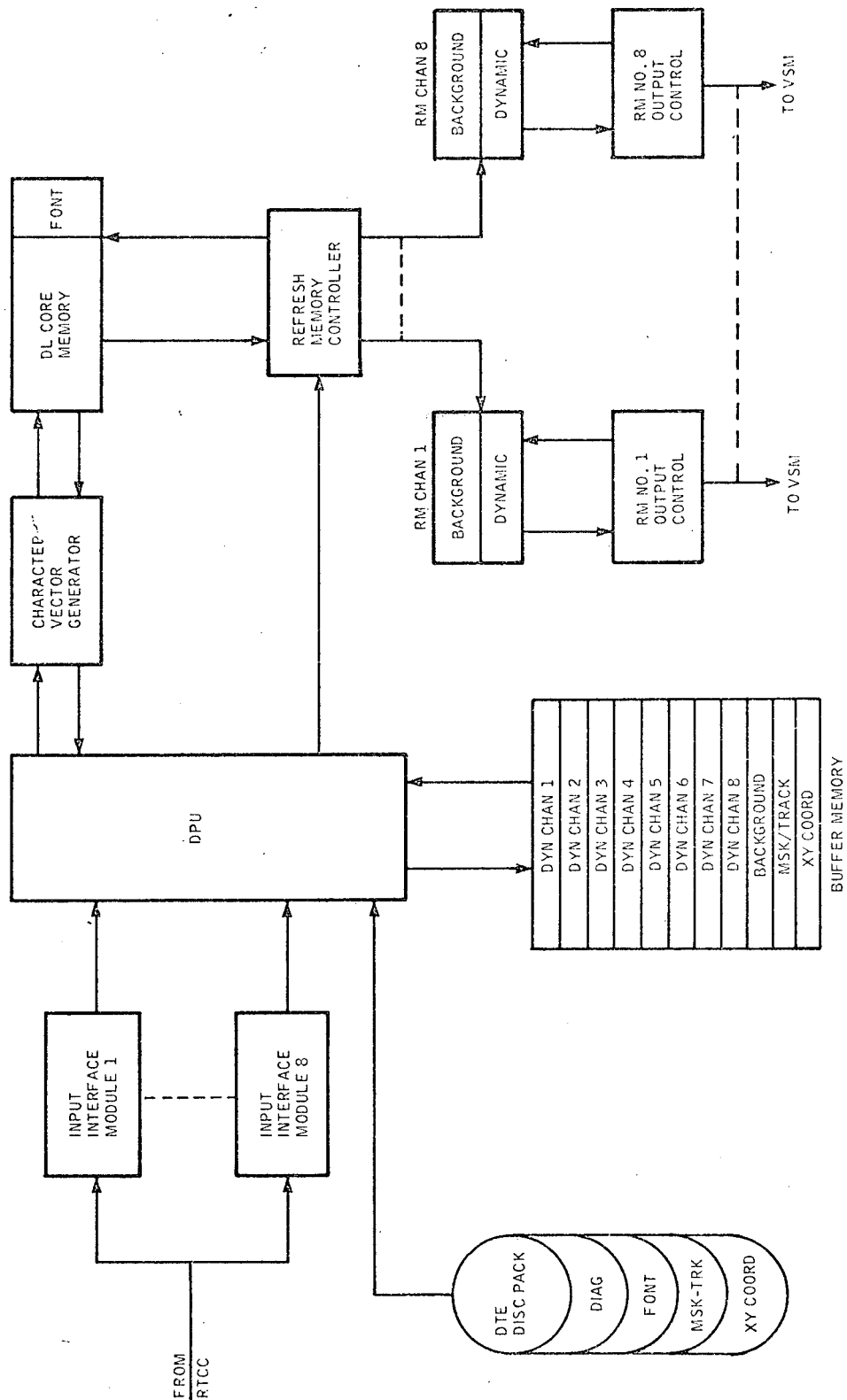


Figure 3-3 DTE Display System

3.4 DISPLAY IDENTIFICATION

Proper identification of DTE formats is required to provide for control and reporting during the various stages of development. The primary method of identification is the MSK number which is the operational identifier by which a display is selected. Additional identification is provided by serial numbers and alphabetic designators. The following paragraphs describe the entries on each display and those in the DRAFT table of contents block that occur when a display is saved.

- A. Manual Select Keyboard Number. The MSK number is placed on the DTE formats both dynamically and statically. The two numbers are located side-by-side in the upper right corner of the display, identifying the matching background static data and the real-time dynamic data.
- B. Format Control Number. The format control number (FCN) for DTE formats is a 4-digit serial number which positively identifies each background. Any change to a display affecting the background configuration requires assignment of a new number.

The FCN is located in the upper left of the display on the same line as the dynamic and static MSK numbers.

- C. Program Change Letter. The program change letter (PCL) is a dynamic letter following the static FCN on the display. This alphabetic designator identifies a change to the computer program for that display output processor. The first change is indicated by an A, the second by a B, etc.

3.5 DESIGN

3.5.1 General

Design of a DTE display format is divided into specification of three types of data: background, dynamic, and descriptive. Both background and dynamic data may be added, changed, moved, or deleted from the display using DRAFT to achieve the most comprehensible and useful display format. Descriptive data is entered or deleted within a fixed format and consists of TOC identification, header data applying to the display as a whole, and FDS data applying to individual parameters.

PHO-TR409 DRAFT II programming requirements contains a detailed description of DRAFT system functions used for DTE display design.

3.5.2 Background Data

- A. Alphanumerics. Alphanumerics are entered through the ANK after a series of DRAFT matrix selections. The designer moves the pen over the grafacon tablet to position a pointer cursor symbol within a selection matrix box on the instruction monitor. Pushing the cursor action switch toward the IM selects that action sequence from the matrix. Pushing the cursor action switch to the left toward the DM selects the location at the tip of the cursor as the position for data to be placed.

The following series of actions will construct a background data group:

- Select: DISPLAY DESIGN
- Select: CONST, ALPHA/DYNAM

Note: At this point an exact coordinate versus standard character line option is presented.

- Select: COORDINATE
- Point: Cursor near center of display monitor

- Type: Alphanumeric data using blank key for space; data appears across bottom of IM
- EOT: Strike EOT key to end construction of group; line of data is transferred to DM with first character at location pointed to with cursor.

Additional selections may have to be made to move, copy, modify, or erase this data group.

B. Lines. Lines are constructed by selecting CONST, LINE-ELLIPS, selecting SINGLE, JOINED, or ELLIPS, and then pointing to the desired coordinate positions on the DM.

- SINGLE: Constructs a line between each pair of points entered
- JOINED: Constructs a line between the first and each successive point entered
- ELLIPS: Constructs an ellipse or circle with axis dimension as entered under XAXIS and YAXIS
- NUMBER: Specifies the interval for dash lines or symbols when they are more useful
- SYMBOL: Provides for keyboard entry of the symbol desired for a symbol line.

Reselection at the CONST level of the DESIGN MATRIX begins another series of line construction actions. Any line may be moved, copied, or erased.

C. Grids. Construction of grids for graphs consists of typing on the plot FDS IM entry format the limits and divisions for each axis of the grid. Plot FDS form appears on the IM.

- Select: CONST, GRAPH

- Type: Minimum X AXIS coordinate, EOT
- Maximum X AXIS coordinate, EOT
- Number of X AXIS dimensions, EOT
- Minimum Y AXIS coordinate, EOT
- Maximum Y AXIS coordinate, EOT
- Number of Y AXIS dimensions, EOT

After the last EOT, the grid appears on display monitor. The grid may be moved, copied, or erased.

- D. Entity. The entity mode provides for grouping during constructing any number or combination of alphanumeric, line, or grid data. CONST, ENTITY is selected before the individual elements are constructed, and END, ENTITY is selected after the last entry is completed.

The entity may then be moved, copied, modified or erased as a single unit. In addition, an entity library provides for temporary storage and recall of the entity.

3.5.3 Dynamic Data

Dynamic data location and extent is symbolized on the display monitor by entry of dot boxes, decimals, colons, or plus signs. The letters D and C may be substituted for decimals and colons. The dot box or any other alphanumeric acts as a location holder for the data to be presented on the display in real time. Entry of dynamic data is delineated by striking the DYN key before and after entry of the place holding symbols. The second strike of the DYN key presents the IM descriptive data entry format.

3.5.4 Descriptive Data

Background or static data is self-evident as to meaning or significance, but dynamic data requires additional description as to source, meaning, and handling by the computer.

Descriptive data entered on the DRAFT IM is categorized as TOC and header data, alpha FDS (tabular) data, and plot FDS (graphic) data.

3.5.4.1 TOC and Header Data

Header data includes descriptive data relating to the complete display. The following describes each entry within the header area following the MSK, FCN, PCL, and status entered in the TOC area.

A. Type Entry

- TAB0 - Trajectory tabular display
- TAB1 - SMEK tabular telemetry display
- TAB3 - Manual entry device display
- TAB4 - High-speed digital telemetry display
- TAB5 - Special telemetry display
- PLT1 - Trajectory plot
- PLT2 - Telemetry plot.

B. Missions. This area designates up to three missions for which the display is applicable.

C. DRK Title. The DRK title is the abbreviated form used on film reticles placed in each button of the display request keyboard.

D. Display Title. The display title is the complete title used on the display format.

E. SMEK Number. This number identifies the summary message rebroadcast format applicable to the display.

F. FDSC Identification. This ID number entry identifies the FDSC responsible for a program (PCL) change.

- G. Size. This number designates the character size used for the bulk of the alphanumerics on the display.
- H. Update Rate. This entry is the time interval between plot updates and is specified in seconds.
- I. Sunflower. The sunflower entries identify the vehicle associated with each of the dynamic loss-of-sync asterisks. Entries correspond right-to-left with symbols on the display.

If the loss-of-sync indicators for these vehicles are desired, the following three-digit ID must be used:

- IU4 instead of IUS4
 - S4U instead of S4IU
 - LVC instead of LVDC
 - SLP instead of SLVP
 - ATS instead of ATMS.
- J. AGC. When only one command module computer downlist is updated, an "X" is entered for powered, rendezvous, constant, or update. Otherwise, no entry is made.
 - K. Non-Applicable Entries. PG22, LGC, and lunar align entries are not used for Skylab displays.
 - L. Comments. Comments relating to the display as a whole may be entered when needed.

3.5.4.2 Tabular Data

The alpha FDS IM display provides for entry of tabular data for one dynamic data group. The character size, coordinates, dynamic data symbol configuration, and sequence number are displayed by the program automatically.

A. External Name. The external name entry consists of the telemetry measurement number or, in the case of special parameters, the identifying number provided by NASA Data Processing Branch (DPB). All computations, MED's, and logic are described by a unique external name which consists of the vehicle TLM system designator such as CSM, IU, SI, SII, or AMD, followed by a four-digit number and a letter which defines the type of special handling required. For example:

- "M" for data entered via a manual entry device (MED)
- "C" for computation involving one or more telemetry parameters
- "L" for special logic involving one or more telemetry parameters.

Table 3-1 correlates measurement numbers applicable to RTCC receipt time and site ID with vehicle type. The external name need not be right- or left-adjusted, and blanks are ignored by IBM's program. The legal character entries are as follows:

Legal Character Entries

A	N	0	=
B	O	1	/
C	P	2	(
D	Q	3)
E	R	4	:
F	S	5	*
G	T	6	
H	U	7	
I	V	8	
J	W	9	
K	X	.	
L	Y	+	
M	Z	-	

TABLE 3-1
MEASUREMENT NUMBERS

SITE ID	RTCC GMT	VEHICLE
SISITE	SIRTCCGMT	SIB
SISITE	SIRTCCGMT	SIC
SIISITE	SIIRTCCGMT	SII
IUSITE	IUTCCGMT	IU5
IUSITE	IUTCCGMT	IU2
S4BSITE	S4BRTCCGMT	S4B
IUS4SITE	IUS4RTCCGMT	IUS4
IUS4SITE	IUS4RTCCGMT	S4IU
AMQSITE	AMQRTCCGMT	AMQ
LVDCSITE	LVDCRTCCGMT	LVDC
SLVPSITE	SLVPRTCCGMT	SLVP
CSMSITE	CSMRTCCGMT	CSMH
CSMSITE	CSMRTCCGMT	CSML
CMCSITE	CMCRTCCGMT	CMCH
CMCSITE	CMCRTCCGMT	CMCL
ATMSITE	ATMRTCCGMT	ATM
ATMSITE	ATMRTCCGMT	ASAP
AMSITE	AMRTCCGMT	AM
AMSITE	AMRTCCGMT	AMP1
AMSITE	AMRTCCGMT	AMP2
AMSITE	AMRTCCGMT	AMP3
AMSITE	AMRTCCGMT	AMP4

B. Format. This entry is transferred by the program from the dynamic data entry on the display monitor. Sixteen characters plus the limit sense diamond are displayed exactly as entered on the DM. When a margin return (MR) is used in dynamic data on the DM, it is displayed in this field as a slash (/).

1. Legal Character Entries. Any DTE character may be used on DRAFT in a dynamic data group. The DOT BOX has been designated as the unique character symbolizing dynamic data. Only the following characters are transferred as outputs on the FDS listing and FDS tape:

<u>TYPE OF NUMBER TO BE DRIVEN</u>	<u>USABLE CHARACTERS</u>
Time	X + . : C D
Decimal	X + . D
All other	X

2. Signs. IBM drives a minus sign when the measurement is negative, whether it is specified or not. A plus sign will only be driven when it is specified.
3. Multi-Line Entries. When dynamic data is to be displayed on two lines for one parameter, the DRAFT II system operator will use the margin return key to create the second line. The DRAFT II program will substitute the slash for the margin return in the IM alpha FDS, the FDS listing, and the FDS tape.

As an example, XXXXC/XXCXX will cause IBM to drive four digits and a colon in line 1 and two digits, a colon, and two more digits in line 2. Any time a number is to be broken into two lines, one of two conditions must exist to enable proper interpretation by IBM's program: line 1 ends with a colon or line 2 begins with a decimal or a colon.

- C. Suppress Limits. An entry of "X" indicates that display of the limit sense diamond is to be suppressed. The site parameter is always suppressed.

- D. Type of Parameter. The TYPE entry contains information necessary to further describe the FORMAT configuration. The characters in this field may have embedded blanks and may appear anywhere within the field. If the field is left blank, the DEC option is assumed.

The acceptable TYPE codes are as follows:

- DEC - Decimal
- OCT - Octal
- HEX - Hexadecimal
- BIN - Binary
- BLVL - Bilevel
- RTXT - Remote text
- S - Time (seconds)
- M - Time (minutes)
- H - Time (hours)
- D - Time (days)
- SC - Time (seconds, centiseconds)
- MS - Time (minutes, seconds)
- HM - Time (hours, minutes)
- DH - Time (days, hours)
- MSC - Time (minutes, seconds, centiseconds)
- HMS - Time (hours, minutes, seconds)
- DHM - Time (days, hours, minutes)
- HMSC - Time (hours, minutes, seconds, centiseconds)
- DHMS - Time (days, hours, minutes, seconds)

- DHMSC - Time (days, hours, minutes, seconds, centiseconds).

Note: No entry for milliseconds in TYPE field; just extra dynamic data symbols on the display.

- E. Bilevel. Entries are made in bilevel only if BLVL is entered under TYPE. The first four characters are those displayed as dynamic data to represent the parameter "0" condition. The second four characters are those displayed as dynamic data to represent the parameter "1" condition. One of the two entries will be displayed in the dynamic data location during real time use of the display. Eight characters, either visible or blank, must be entered in the bilevel field. When the number of character positions reserved on the display by the dynamic data symbols is less than four, i.e., 3, 2, or 1, the 1 and 0 entries are truncated from the right.

Example: HOLDDROP is entered in bilevel field.

POSITIONS RESERVED	CONDITION 1	CONDITION 0
0 0 0 0	HOLD	DROP
0 0 0	HOL	DRO
0 0	HO	DR
0	H	D

- F. Label/Comments. This entry provides for a label or comments identifying the parameter.
- G. PCL. This entry is the program change letter (PCL) identifying the parameter as a change. The letter corresponds with that of the display PCL.

3.5.4.3 Plot Data

The plot FDS provides for entry of all data related to graphs including the grid data, scale data, and parameter data. Entry of static background curve data is optional subsequent to grid and scale data entry.

- A. Grid Data. The minimum and maximum limits of the plot are entered in terms of 1024 X 1024 coordinates for both X axis and Y axis. The divisions entry determines the number of plot divisions for both X and Y. After EOT of the Y divisions entry, the grid is constructed on the DM by the program. No lines are constructed for a 0 entry. Only the limits are constructed for a 1 entry. Increasing the number of divisions increases the number of lines required and constructed.
- B. Scale Data. The minimum and maximum limits in terms of engineering units are entered for both horizontal (X axis) and vertical (Y axis) scales. The page up and page down function provided for entering data relative to the appropriate scale. Three scales identified from the plot area outward may be specified. Figure 3-4 illustrates scale numbering convention.
- C. Parameter Data. Parameter data defines the source of input for each axis and the plot character and character size for each X and Y axis pair. A vehicle identifier label and descriptive comments may also be entered for each parameter (see Table 3-2). A page up and down function permits associating more than one parameter or pair of parameters with each scale pair. The sequence identifier is entered by the program with the first digit always corresponding to the scale number.
- D. Curve Data. Curve data entry is made after paging to the correct scale data entry. A label identifier is entered for each curve to be constructed. Optional entries can be made to specify interval for dash or symbol lines, symbol and symbol size. The number of points entry indicates the number of points to be interpolated by the curve fairing program. The INV entry is not used.

Engineering unit XY values are entered for sufficient points to determine the shape of the curve.

Selection of CONSTRUCT causes the program to fair a curve through a total number of specified data points and additional interpolated points equal to the number of points entry.

The smoothness and overall shape of the curve may be modified by adding or deleting points or by enlarging the number of

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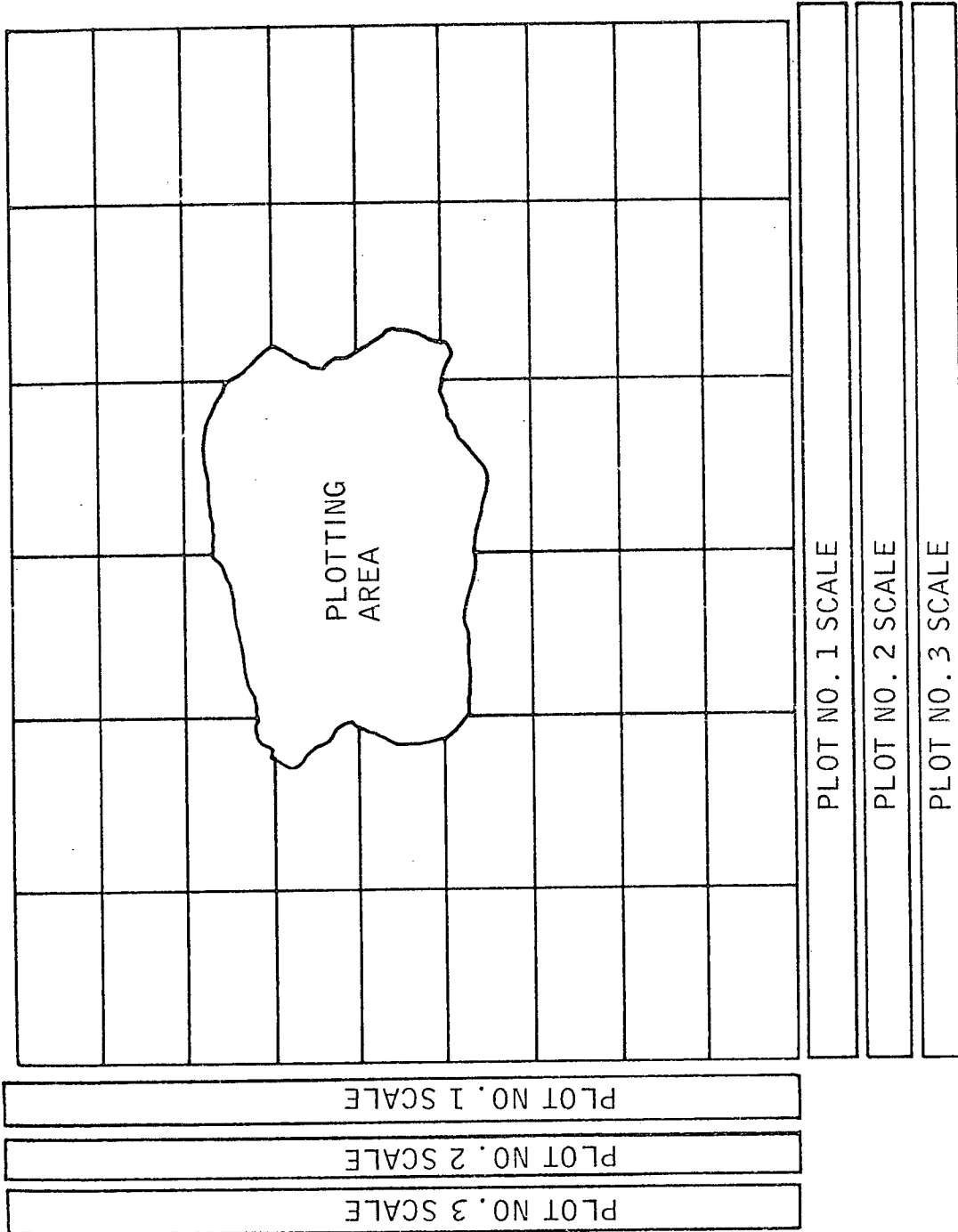


Figure 3-4 Scale Numbering of Multiscale Plots

TABLE 3-2
IML VEHICLE ID'S

VEHICLE	LIVE ID (OCTAL)	PB/DUMP ID (OCTAL)	COMMENTS
SIB	203	-	SIB MEASUREMENTS
SIC	204	-	SIC MEASUREMENTS
SII	205	-	SII MEASUREMENTS
S4B	206	-	S4B MEASUREMENTS
IUS4	207	-	IUS4 - IU PRIME
S4IU	210	-	S4IU - S4 PRIME
IU2	211	-	IU - 200 SERIES
LVDC	212	-	LVDC MEASUREMENTS
CSMH	213	313	CSM HIGH BIT RATE
CSML	214	314	CSM LOW BIT RATE
CMCH	215	315	CMC HIGH BIT RATE
CMCL	216	316	CMC LOW BIT RATE
ATM	217	317	APOLLO TELESCOPE MOUNT
AM	224	324	AIRLOCK MODULE
AMP1	-	326	AM PRIME SUBFRAME 1 DUMP
AMP2	-	327	AM PRIME SUBFRAME 2 DUMP
AMP3*	-	331	AM PRIME SUBFRAME 3 DUMP
AMP4	-	332	AM PRIME SUBFRAME 4 DUMP
AMQ	234	-	ANALOG MULTIPLEXER QUANTIZER
IU5	236	-	IU - 500 SERIES
AME1*	-	333	AM EXPERIMENT DUMP 1
AME2*	-	337	AM EXPERIMENT DUMP 2

*RECEIVED IN ADDT MODE ONLY.

points entry. Entry of a partition point (P) permits division of a curve into two or more faired sections where the same curve must represent a sharp change in shape.

A paging option provides for entry of data in the EU point table in groups of ten.

3.6 STANDARD DTE FORMATS

Simplification of display programming is possible when a number of display formats can be designed and displayed in similar or standard configurations. Such standardization results in an appreciable saving of programming and checkout time.

The majority of DTE displays are adapted to standard display formats for this reason. Full descriptions of the programming requirements for these displays will be found in PHO-TR485A.

Basic displays and entities are available in the DRAFT library for the standard formats included here. Where static data such as lines or alphanumerics are shown, these will appear on all displays using the standard format. The dynamic data configurations and locations shown are also standard and will appear in the indicated location on all displays. For detailed usage requirements, the Philco Display Formats Design engineer should be consulted.

3.6.1 Background Identification

The standard location (X and Y coordinates) for the size 3 MSK, FCN, and title on all displays is as follows:

- FCN: X = 22; Y = 1004
- MSK: X = 940; Y = 1004
- TITLE: X = center 508; Y = 1004.

3.6.2 History TAB Display

Figure 3-5 shows the DRAFT basic display for history tab displays. Coordinates shown are 1024 coordinates for the lines. Coordinates in parentheses are for the second (double) lines emphasizing the high-speed data area.

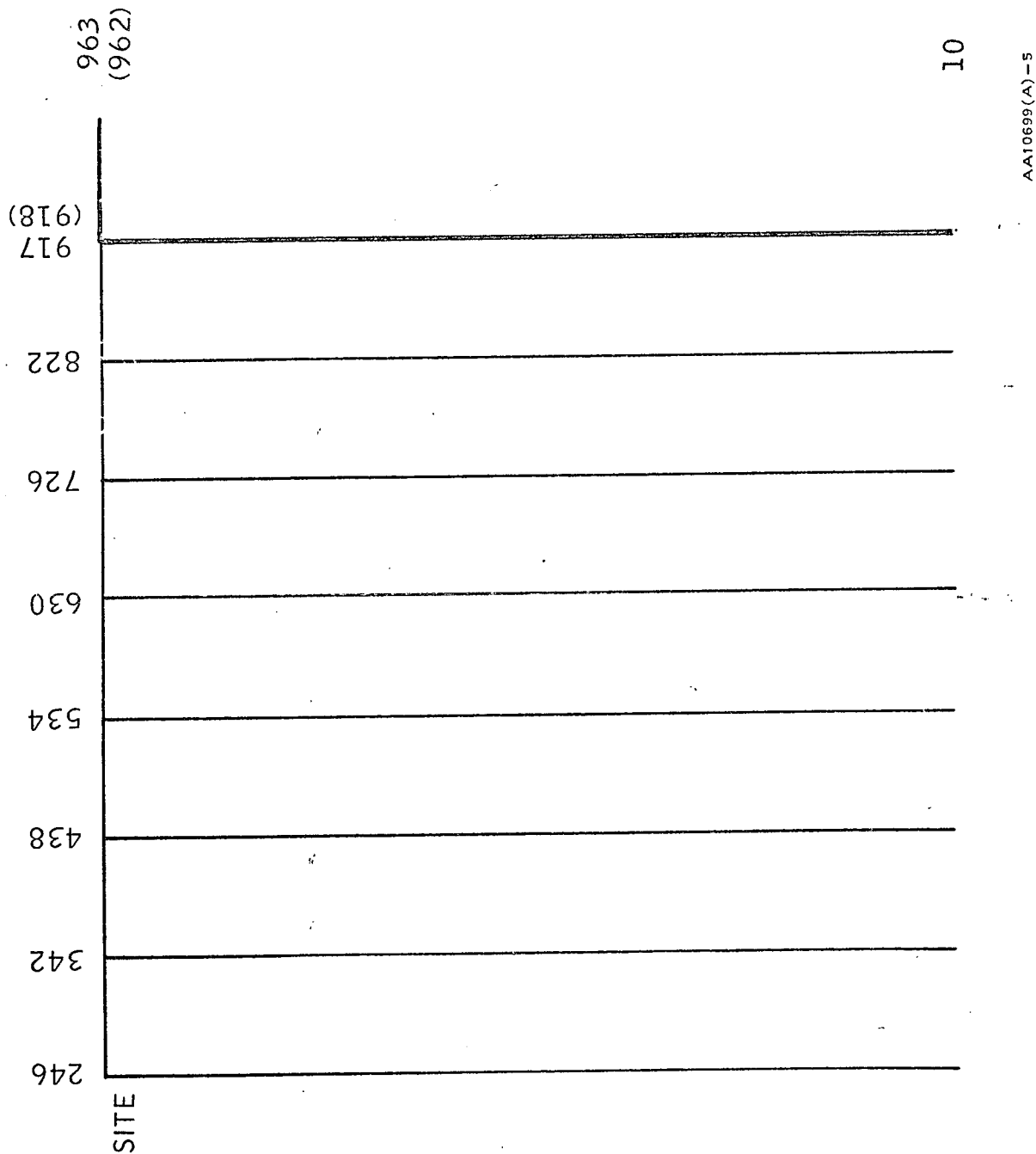


Figure 3-5 History Tab Display Basic Format

3.6.3 Universal Plot

Figure 3-6 shows the basic display for universal plot backgrounds. The plot limits are X=198 and 1014, Y=86 and 854 in 1024 coordinates. The background MSK, FCN, and title are entered as size 2. See Table 3-3.

3.6.4 Dynamic Data Identification

The standard location in 1024 coordinates for the dynamic size 3 MSK and PCL is as follows:

- MSK: X = 843; Y = 1004

- PCL: X = 112; Y = 1004

3.6.5 Vehicle Loss-of-Sync Indicators

A dynamic data size 5 asterisk is used to indicate vehicle loss-of-sync. The FDS entry data is titled SUNFLOWER and specifies the applicable vehicles in reverse order (3,2,1.). The three positions are as follows:

- 1: X = 800; Y = 996

- 2: X = 750; Y = 996

- 3: X = 700; Y = 996

3.6.6 Live, Playback, or Dump Indicator

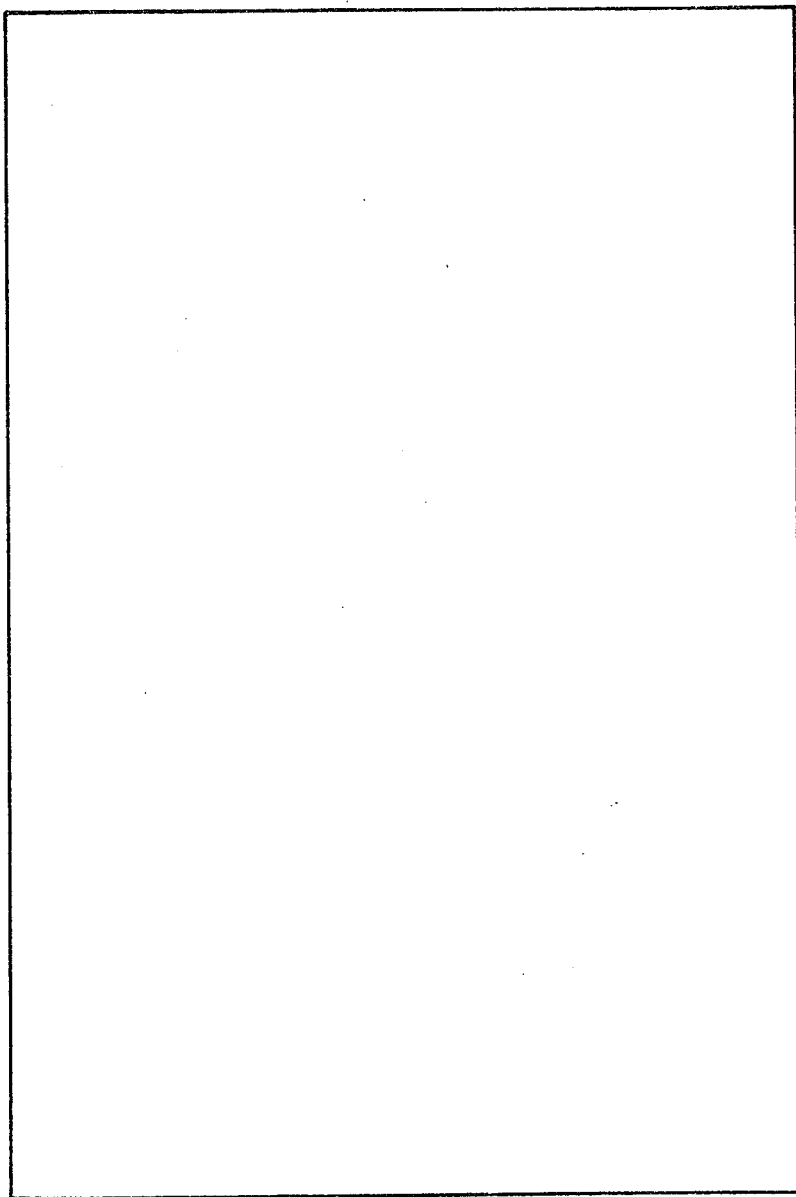
The live, playback, or dump indicator will size 2 at the following locations:

- 1: X = 775; Y = 996

- 2: X = 725; Y = 996

- 3: X = 675; Y = 996

UPDATE RATE SEC POINTS DATA = Δ
 = X = 0 = +



S/C = GND =

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Figure 3-6 Universal Plot Basic Display

TABLE 3-3
UNIVERSAL PLOT

BACKGROUND DATA	X COORDINATE	Y COORDINATE
UPDATE RATE	22	982
SEC	294	982
POINTS	392	982
DATA	678	982
=X	198	918
=0	454	918
=+	726	918
=Δ	966	918
S/C=	486	22
GND=	758	22

3.7 DRAFT DTE END ITEMS

DRAFT operational end items for DTE displays include FDS and background tapes, documentation and working listings, and the DTE mission disc pack. These are described in more detail in the following paragraphs.

3.7.1 Table of Contents

Table 3-4 shows a typical TOC page from a DRAFT/DTE working listing. The MSK, FCN, and PCL have been previously defined. A "C" in the status field indicates the display is completed and mission ready. The type entry is used during output to separate telemetry (right-adjusted dynamic data coordinates) from trajectory (left-adjusted dynamic data coordinates) displays. The three mission designators are self-explanatory. The title is the DRK title entry. All TOC entries originate from the header area which is filled in when a display is saved.

3.7.2 Format Description Sheet (FDS) Tape

Three categories of displays are involved: tabular (trajectory and telemetry), trajectory plots, and telemetry plots (universal plots). Header information common to each category will be assigned to the same card column location.

The physical aspects of the FDS tape are as follows: card image, EBCDIC with a fixed block header for all displays, and a variable block for the body of the FDS.

3.7.2.1 FDS Header Information (Fixed Block)

A. Card No. 1

1. CC1-4. Four bytes for type of display.

TRAJECTORY

TAB0
PLT1

TELEMETRY

TAB1
TAB3
TAB4
TAB5
PLT2

TABLE 3-4
DRAFT TOC LIST

MSK	FCN	PCL	STATUS	TYPE	MISSIONS			TITLE		
0256	7486	A	B	TAB0	SKYL1	SKYL2	SKYL3	ATMDC	NAV	VERIFY
0256	7542	B	B	TAB0	SKYL1	SKYL2	SKYL3	ATMDC	MAV	VERIF
0257	7180		C	TAB5	SKYL1	SKYL2	SKYL3	ATM	CMO	VER
0258	7181		C	TAB5	SKYL1	SKYL2	SKYL3	ATMDC	MEM DUMP	TLM
0259	7182		C	TAB5	SKYL1	SKYL2	SKYL3	ATMDC	SELECTED	PARMTR
0260	7183		C	TAB0	SKYL1	SKYL2	SKYL3	ATMDC	MEMORY	LOAD COM
0261	7184		C	TAB0	SKYL1	SKYL2	SKYL3	ATMDC	COM GEN3	INTM/TAC
0262	7185		F	TAB4	SKYL1	SKYL2	SKYL3	ATMDC	ATTITUDE	DISPLAY
0263	7267		C	TAB0	SKYL1	SKYL2	SKYL3	TARGET	LOAD/	DUMP/ALT
0263	7502	A	B	TAB0	SKYL1	SKYL2	SKYL3	TARGET	LOAD/	DUMP/ALT
0264	7116		C	TAB0	SKYL1	SKYL2	SKYL3	CMC	EXTERNAL	V UPDTE
0266	7117		C	TAB0	SKYL1	SKYL2	SKYL3	CMC	REFSMAT	UPDATE
0267	7428	A	C	TAB4	SKYL1	SKYL2	SKYL3	CMC DSKY	STATE	BUFF MON
0270	7119		C	TAB0	SKYL1	SKYL2	SKYL3	QWS NAV	UPDATE	TO CMC
0271	7062		C	TAB0	SKYL1	SKYL2	SKYL3	GUIDANCE	ENT/ART	DIGITALS
0276	7120		C	TAB0	SKYL1	SKYL2	SKYL3	CSM NAV	UPDATE	TO CMC
0281	7121		C	TAB0	SKYL1	SKYL2	SKYL3	CMC UPDT	ERASABLE	MEMORY A
0282	7122		C	TAB0	SKYL1	SKYL2	SKYL3	CMC UPDT	ERASABLE	MEMORY B
0290	7379		C	TAB5	SKYL1	SKYL2	SKYL3	GUIDC	INSERT	DIGITALS
0330	7429	A	C	TAB0	SKYL1	SKYL2	SKYL3	RFC	LAUNCH	DIGITALS
0331	7063		C	TAB0	SKYL1	SKYL2	SKYL3	MODE 1/2	ABORT	DIGITALS
0332	7056		C	TAB0	SKYL1	SKYL2	SKYL3	ENTRY	MODE III	DIGITALS
0333	7076		C	PLT1	SKYL1	SKYL2	SKYL3	RFC	TEF	VS RIP
0335	7052		C	TAB0	SKYL1	SKYL2	SKYL3	RETRO	TARGET	TABLE
0340	7123		C	TAB0	SKYL1	SKYL2	SKYL3	CMC TIME	INCREMNT	UPDATE
0341	7124		C	TAB0	SKYL1	SKYL2	SKYL3	CMC LIFT	OFF TIME	UPDATE
0343	7125		C	TAB0	SKYL1	SKYL2	SKYL3	CMC	ENTRY	UPDATE
0347	7064		C	TAB0	SKYL1	SKYL2	SKYL3	GROUND	TRACK	DIGITALS
0349	7053		C	TAB0	SKYL1	SKYL2	SKYL3		PSAT	
0354	7065		C	TAB0	SKYL1	SKYL2	SKYL3	RETRO	ELAPSED	TIME
0355	7473		C	TAB0	SKYL1	SKYL2	SKYL3		RCT	
0356	7057		C	TAB0	SKYL1	SKYL2	SKYL3		RFD	
0357	7058		C	TAB0	SKYL1	SKYL2	SKYL3	BLOCK	DATA	TABLE
0370	7022		C	TAB0	SKYL1	SKYL2	SKYL3	CSM INP	MASS	PROPERTY
0373	7449		C	TAB0	SKYL1	SKYL2	SKYL3	CSM OUT	DAP MASS	PROPERTY
0376	7024		C	TAB0	SKYL1	SKYL2	SKYL3	CG SUM	MASS	PROPERTY
0400	7081		C	TAB4	SKYL1	SKYL2	SKYL3	EFCCM	EPS SUM	MSK 0400
0400	7528		B	TAB4	SKYL1	SKYL2	SKYL3	FGII	EPS SUM	
0401	7082		C	TAB1	SKYL1	SKYL2	SKYL3	SWS EPS	DIST TAB	
0410	7083		C	TAB4	SKYL1	SKYL2	SKYL3	AM EPS	HIGH DEN	
0411	7084		C	TAB1	SKYL1	SKYL2	SKYL3	AM EPS	DIST TAB	
0412	7085		C	TAB1	SKYL1	SKYL2	SKYL3	AM BATS	CHG TAB	MSK 0412
0412	7530		B	TAB1	SKYL1	SKYL2	SKYL3	AM BATS	CHG TAB	MSK 0412
0413	7086		C	TAB1	SKYL1	SKYL2	SKYL3	AM BAT	TAB	MSK 0413
0414	7087		C	TAB1	SKYL1	SKYL2	SKYL3	QWS SAS	1-4 TAB	
0415	7088		C	TAB1	SKYL1	SKYL2	SKYL3	QWS SAS	5-8 TAB	
0416	7089		C	TAB1	SKYL1	SKYL2	SKYL3	AM EPS	TEMP TAB	
0420	7090		A	TAB4	SKYL1	SKYL2	SKYL3	ATM EPS	HIGH DEN	
0421	7091		C	TAB1	SKYL1	SKYL2	SKYL3	ATM EPS	DIST TAB	
0421	7531		B	TAB1	SKYL1	SKYL2	SKYL3	ATM EPS	DIST TAB	

2. CC6-9. Four bytes for the MSK number of display.
3. CC11-14. Four bytes for the FCN of display.
4. CC15. One byte for the PCL.
5. CC17. One byte describing the status of the display.
6. CC19. One byte for character size this display (1,2,3, 4, or 5).
7. CC20-36. Seventeen bytes for mission designators (possibly 3 missions).
8. CC38-40. Three bytes for sunflower option, vehicle No. 1.
9. CC42-44. Three bytes for sunflower option, vehicle No. 2.
10. CC46-48. Three bytes for sunflower option, vehicle No. 3. Note that the previous three data entries (CC38-CC48) are replaced by the update rate on universal plot (PLT2) displays.
11. CC49-50. Two bytes for SMEK number.
12. CC52-54. Three bytes for FDSC number.
13. CC76-80. Five bytes describing the total number of bytes of FDS data (80 X number of rows used).

B. Card No. 2

1. CC1-11. Eleven bytes for downlist indicator; if the display is updated from more than one downlist, all columns are left blank.

2. CC1. Powered downlist.
 3. CC2. Rendezvous downlist.
 4. CC3. Coast downlist.
 5. CC4. Update downlist.
 6. CC13-52. Forty bytes for display title.
 7. CC54-79. Twenty-six bytes for DRK title.
- C. Card No. 3. This card contains 80 bytes for comments or expansion if needed.

3.7.2.2 Tabular Display Parameter Cards

- A. CC2-13. Twelve bytes for the external name.
- B. CC14-29. Sixteen bytes for the format field. The following characters may be used in the format field: X, +, ., D, :, C. The DRAFT II system operator will use the margin return key to create the second and third lines of data on the TV monitor without displaying the slash. The DRAFT II output program will substitute the slash for the margin return on the FDS listing and tape.

As seen in the example XXXXC/XXCXX, this will cause IBM to drive four digits and a colon in line 1 and two digits, a colon, and two more digits in line 2. Any time a number is to be broken into two lines, one of two conditions must exist: line 1 ends with a colon or line 2 begins with a decimal or a colon.

- C. CC30. One byte for the error column field.
- D. CC31-35. Five bytes for the type field.
- E. CC36-43. Eight bytes for the if bilevel field.

- F. CC44-51. Eight bytes for the coordinate field. IBM's terminology for 1024 X 1024 coordinates is raster units. The COORD field consists of two four-character fields. The first is the X coordinate field, and the second is the Y coordinate field. The numbers placed in these fields will be the X and Y coordinates of either the left-most dynamic character or the right-most dynamic character, depending on whether the display is trajectory or telemetry as indicated in CC1-4 of the fixed block header information.

For the trajectory displays, the X coordinate field will contain the X coordinate of the left-most dynamic data characters. For telemetry displays, the X coordinate field will contain the X coordinate of the right-most dynamic character (excluding the limit diamond if present). When dynamic data for a telemetry display appears on more than one line, the COORD field will contain the coordinates of the dynamic data character immediately preceding the first slash symbol (margin return).

- G. CC52. One byte for the size field.
- H. CC53-72. Twenty bytes for the label comments field.
- I. CC77-79. Three bytes for the SEQ number.
- J. CC80. One byte for the change letter.

3.7.2.3 Trajectory Plot Parameter Cards

Fields are defined as follows for the plot information.

- A. CC2-13. Twelve bytes for the external name field.
- B. CC14-15. Two bytes for the plot character field. This is entered for each external name. Lower case alpha characters are output with an L prefix (e.g., LX is lower X).
- C. CC16-27. Twelve bytes for the EUMIN and EUMAX. These are entered for each external name entry.

- D. CC29. One byte for the character size field.
- E. CC31. One byte for the scale number field.
- F. CC32-47. Sixteen bytes for the coordinate minimum/maximum field. Either X or Y coordinates are given for each external name entry.
- G. CC48-67. Twenty bytes for the label comments field.
- H. CC77-79. Three bytes for the SEQ number.
- I. CC80. One byte for the program change letter.

The bottom half of the plot FDS describes tabular information appearing on a plot display. Parameter information is entered exactly as it would be for tabular displays.

3.7.2.4 Universal Plot Parameter Cards

- A. Line 1. This line describes the parameter data associated with the X axis, scale 1, parameter 1 entry.
 - 1. CC1. One byte (X) constant.
 - 2. CC2. One byte (T) for time plot. Program checks label field of X axis, scale No. 1, parameter No. 1 for "T=" code. If otherwise, entry is blank.
 - 3. CC3-5. Up to three bytes for vehicle designator (SLV, CSM, CMC, AMD, AMQ, ATM, AM, STS) of X axis, scale No. 1, parameter No. 1.
 - 4. CC7-18. Twelve bytes for the RTCC external name of X axis, scale No. 1, parameter No. 1.
 - 5. CC20-39. Twenty bytes for label and comments field of X axis, scale No. 1, parameter No. 1.
 - 6. CC77-79. Three bytes for sequence number (001) constant.
 - 7. CC80. One byte for PCL if any.

- B. Line 2. This line describes the parameter and scale data associated with the Y axis, plot character "X."
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (1) constant.
 3. CC3-5. Three bytes for vehicle designator.
 4. CC6. One byte (R) if scale number is 1, or 1 byte (L) if scale number is 2.
 5. CC7-18. Twelve bytes for the RTCC external name.
 6. CC19. One byte for plotting symbol indicator "X" (constant).
 7. CC20-31. Twelve bytes for label (description) of the parameter (blanks will be treated as spaces).
 8. CC32-39. Eight bytes for comments or parameters description and engineering units.
 9. CC77-79. Three bytes for sequence number (002) constant.
 10. CC80. One byte for PCL (otherwise blank).
- C. Line 3. This line describes the parameter and scale data associated with the Y axis plot character "0."
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (2) constant.
 3. CC3-5. Up to three bytes for vehicle designator.
 4. CC6. One byte (R) if scale number is 1, or 1 byte (L) if scale number is 2.
 5. CC7-18. Twelve bytes for the RTCC external name.

6. CC19. One byte for plotting symbol indicator "0" (constant).
 7. CC20-31. Twelve bytes for label (description) of the parameter (blanks will be treated as spaces).
 8. CC32-39. Eight bytes for comments or parameter description and engineering units.
 9. CC77-79. Three bytes for sequence number (003) constant.
 10. CC80. One byte for PCL (otherwise blank).
- D. Line 4. This line describes the parameter and scale data associated with the Y axis plot character "+."
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (3) constant.
 3. CC3-5. Three bytes for vehicle designator.
 4. CC6. One byte (R) if scale number is 1, or 1 byte (L) if scale number is 2.
 5. CC7-18. Twelve bytes for the RTCC external name.
 6. CC19. One byte for plotting symbol indicator "+" (constant)
 7. CC20-31. Twelve bytes for label (description) of the parameter (blanks will be treated as spaces).
 8. CC32-39. Eight bytes for comments or parameter description and engineering units.
 9. CC77-79. Three bytes for sequence number (004) constant.
 10. CC80. One byte for PCL (otherwise blank).

- E. Line 5. This line describes the parameter and scale data associated with the Y axis plot character "Δ."
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (4) constant.
 3. CC3-5. Three bytes for vehicle designator.
 4. CC6. One byte (R) if scale number is 1, or 1 byte (L) if scale number is 2.
 5. CC7-18. Twelve bytes for the RTCC external name.
 6. CC19. One byte for plotting symbol indicator "Δ" (constant).
 7. CC20-31. Twelve bytes for label (description) of the parameter (blanks will be treated as spaces).
 8. CC32-39. Eight bytes for comments or parameter description and engineering units.
 9. CC77-79. Three bytes for sequence number (005) constant.
 10. CC80. One byte for PCL (otherwise blank).
- F. Line 6. This line describes the engineering units associated with the X axis scale No. 1.
1. CC1. One byte for (X) constant.
 2. CC2. Blank.
 3. CC3-16. Fourteen bytes for EUMIN of X axis scale 1 parameter.
 4. CC17-30. Fourteen bytes for EUMAX of X axis scale 1 parameter (Note: CC3-30 blank if time plot, "T=" code in label field of X axis 1 scale No. 1, parameter No. 1).

5. CC77-79. Three bytes for sequence number (006) constant.
 6. CC80. One byte for PCL (otherwise blank).
- G. Line 7. This line describes the engineering units associated with the Y axis scale No. 1.
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (R) constant.
 3. CC3-16. Fourteen bytes for EUMIN of Y axis, scale 1 parameter.
 4. CC17-30. Fourteen bytes for EUMAX of Y axis, scale 1 parameter.
 5. CC77-79. Three bytes for sequence number (007) constant.
 6. CC80. One byte for PCL (otherwise blank).
- H. Line 8. This line describes the engineering units associated with the Y axis scale 2.
1. CC1. One byte for (Y) constant.
 2. CC2. One byte for (L) constant.
 3. CC3-16. Fourteen bytes for EUMIN of Y axis scale 2 parameter.
 4. CC17-30. Fourteen bytes for EUMAX of Y axis scale 2 parameter.
 5. CC77-79. Three bytes for sequence number (008) constant.
 6. CC80. One byte for PCL (otherwise blank).

3.7.3 Background Tape

The DTE background tape is a nine-track tape containing the 36-bit data words for each display applicable to the mission requested. In addition to the data words, each display is preceded by a header and identification area. The configuration is as follows:

- First 5 bytes - mission number
- Next 5 bytes - date (2 bytes for month, 2 bytes for day, 1 byte for last digit of the year)
- Next 4 bytes - total length of header in bytes (hexidecimal representation with leading zeros)
- Next 1 byte - word length indicator (EBCDIC blank = 5 bytes, EBCDIC semicolor = 6 bytes)
- Next 5 bytes - total length of record in bytes (hexidecimal representation with leading zeros)
- Next 5 bytes - MSK number
- Next 5 bytes - new FCN
- Next 5 bytes - PCL
- Remainder of record - instruction words and data words as they appear on the DTE mission disc pack; the first word after the header information for each background will normally be a begin frame
- End of record.

3.7.4 DTE Disc Pack

The DTE disc packs are produced by Philco off-line programs on the 360/44 computer. Each of the tables and the DTE diagnostic displays may be updated as required.

The track assignments for the mission disc are described in Table 3-5. All references to cylinder are made in octal, and head numbers are given in decimal.

PHO-TR466, *DTE Background Disc Recording Program Requirements* gives detailed information on the disc pack requirements, and PHO-TR503, *DTE Character Font Designs* gives the detailed dot matrix patterns used for the DTE characters.

3.7.5 Documentation

DTE mission display documentation consists of three items: the format change request (FCR), the display specification hardcopy, and the format description sheet. Publication of these three items for each display is made in PHO-TR485B, *MCCH Operational Requirements Control Document*, Volume I. A fourth item, the format description sheet change (FDSC), is published when required.

- A. FCR. The FCR provides for requirement approval signatures or new or changed displays. Space is provided for old and new ID numbers and PCL's and for describing the change requested. Figure 3-2 illustrates this form.
- B. DSH. The DSH replaces the hand lettered display format worksheet. The hardcopy is made from the DRAFT display monitor (DM) and shows both background data and dynamic symbols as they are specified to appear on the real-time DTE display. Figure 3-7 illustrates this form.
- C. FDS. This is a printer listing describing the dynamic data. It gives the source, coordinate location, and configuration of each dynamic data group to be displayed. Additional data and comments are included when needed. With the exceptions noted in Appendix A, it is identical with the FDS tape. Figure 3-8 illustrates this form.
- D. FDSC. This item is originated by IBM to flag needed changes or corrections to the DRAFT data base. It is included, as required, with the above documentation items. Table 3-6 illustrates this form.

TABLE 3-5
DTE DISC PACK TRACK ASSIGNMENTS

TRACK NUMBERS				CONTENTS	OVERFLOW STATUS
FROM		TO			
CYL	HEAD	CYL	HEAD		
000	1	000	5	CHARACTER DOT STORAGE	SET
000	6	000	7	SLIDE/MSK CONVERSION	SET
000	8	000	8	COORDINATE CONV TABLE	SET
000	9	000	9		NOT SET
001	0	061	9	DTE DIAGNOSTICS	AS NECESSARY

FDSC NO. _____

MSK _____ FLT NO. _____ OLD PCL _____ NEW PCL _____

ORIGINATOR _____ EXT _____ DATE _____

DESCRIPTION OF CHANGE:

Figure 3-8

Format Description Sheet Change

TABLE 3-6
FDSC FORM

TYPE	MSK	FCN	P	C	S	MISSIONS	VEH	VEH	VEH	SN	FDSC	TOTAL	SEQ
TAB4	0674	7421		A	2	SKYL1 SKYL2 SKYL3	CSM					10400	001
DOWNLISTING				DISPLAY TITLE									002
				CSM GNC MANEUVER TABLE	E	TYPE	1	BLVL	0	CSM GNC	MANEUVER TABLE		003
				FORMAT						DRK 1	DRK 2	DRK 3	004
				XXXX						CSM GNC	YCORD	S	005
				XX						0598	0982	REPORT TM ST A	006
				CSM						0726	0982	CSM IML STAT US	007
				CSMGM						0278	0950	GMTA	008
				CT0145						0278	0918	CTE	009
				XXXXXX						0950	0918	CSM WT	010
				CSM2103C						0214	0854	WPU QA	011
				CSM3301C						0342	0854	WPU QB	012
				CSM3302C						0470	0854	WPU QC	013
				CSM3303C						0598	0854	WPU D	014
				CSM3304C						0726	0854	WPU QT	015
				CSM2246C						0854	0854	WPU PSM	016
				CSM3305C						0982	0854	WPU TOT	017
				CSM2247C						0214	0822	K QA	018
				CSM1501M						0342	0822	K QB	019
				CSM1502M						0470	0822	K QC	020
				CSM1503M						0598	0822	K QD	021
				CSM1504M						0726	0822	K QT	022
				CSM1516M						0854	0822	K PSM	023
				CSM1505M						0982	0822	K TOT	024
				CSM1517M						0214	0790	PCTU QA	025
				CSM2201C						0342	0790	PCTU QB	026
				CSM2202C						0470	0790	PCTU QC	027
				CSM2203C						0598	0790	PCTU QD	028
				CSM2204C						0726	0790	PCTU QT	029
				CSM2248C						0854	0790	PCTU PSM	030
				CSM2205C						0982	0790	PCTU TOT	031
				CSM2249C						0214	0726	P/T CORR QA	032
				CSM2206C						0342	0726	P/T CORR QB	033
				CSM2207C						0470	0726	P/T CORR QC	034
				CSM2208C						0214	0758	P/T BIAS QA	035
				CSM1511M						0342	0758	P/T BIAS QB	036
				CSM1512M						0470	0758	P/T BIAS QC	037
				CSM1513M						0598	0758	P/T BIAS QD	038
				CSM1514M						0854	0694	MSN PROF PSM	039
				CSM1510M						0854	0758	P/T BIAS PSM	
				CSM1515M						0214	0694	MSN PROP QA	
				CSM1506M						0342	0694	MSN PROP QB	
				CSM1507M						0470	0694	MSN PROP QC	
				CSM1508M						0598	0694	MSN PROP QD	
				CSM1509M									

SECTION 4

PROJECTION PLOTTING

4.1 GENERAL

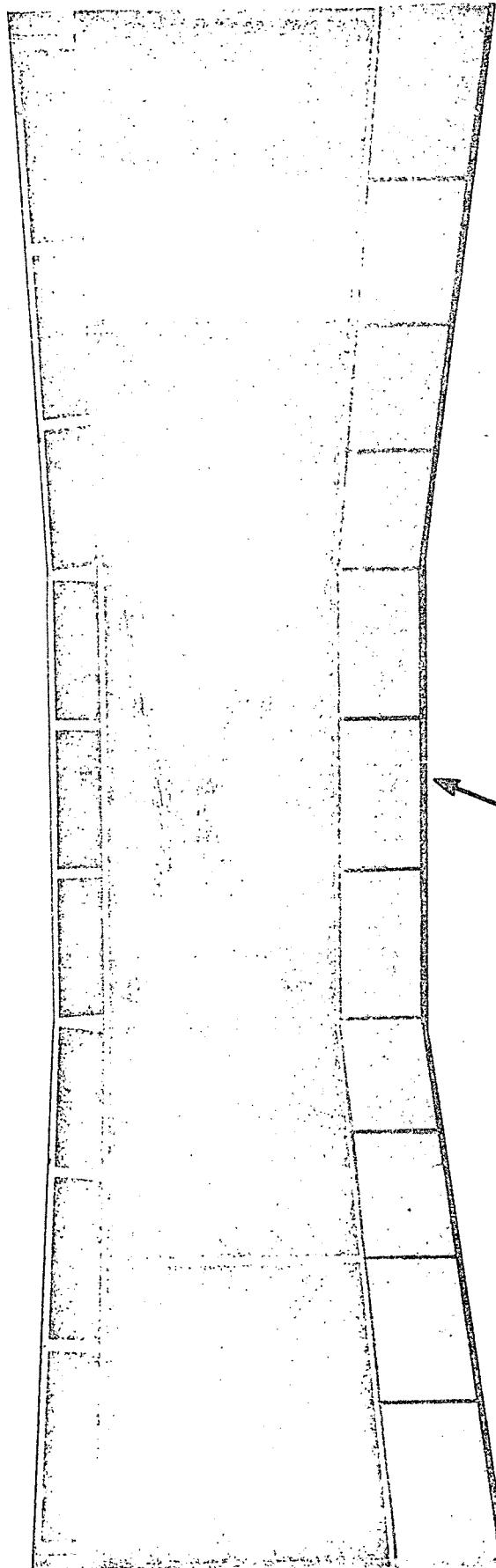
Two types of data are superimposed to form the projection plotting display images in the MCC. The first type is dynamic data consisting of real-time information controlling the styli movement of the scribing projectors and the spacecraft image movement in the spotting projectors. The second type is background static data consisting of reference maps and graphs. The 10 X 20 foot display screen in the Mission Operations Control Room (MOCR) has four scribing projectors and two spotting projectors operating under computer control. The Recovery Control Room display screen (6 feet X 12 feet) has a scribing, a spotting, and a manual scribing projector. The Recovery Control Room also has an electrically driven daylight/darkness projector.

The composited display typically shows a map upon which the location of the spacecraft and present or future groundtracks are superimposed together with some parameter scribed against a graph of altitude. Figure 4-1 shows the MOCR projection screen.

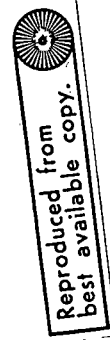
4.2 ORGANIZATIONAL INTERFACES

Figure 4-2 outlines the organizational interfaces and sequential workflow during development of projection plotting displays. The following paragraphs outline each major step.

- A. Inherent display limitations on projection plotting displays include minimum character size and line weights, discriminable colors, and number displays immediately available to program callup.
- B. NASA flight controllers initiate a format change request (FCR) or requirements memo and sketches outlining their projection plotting display requirements.



LD09499 (A)



PROJECTION
PLOT
10' X 20'
SCREEN

Figure 4-1 MOCR Projection Plotting Displays

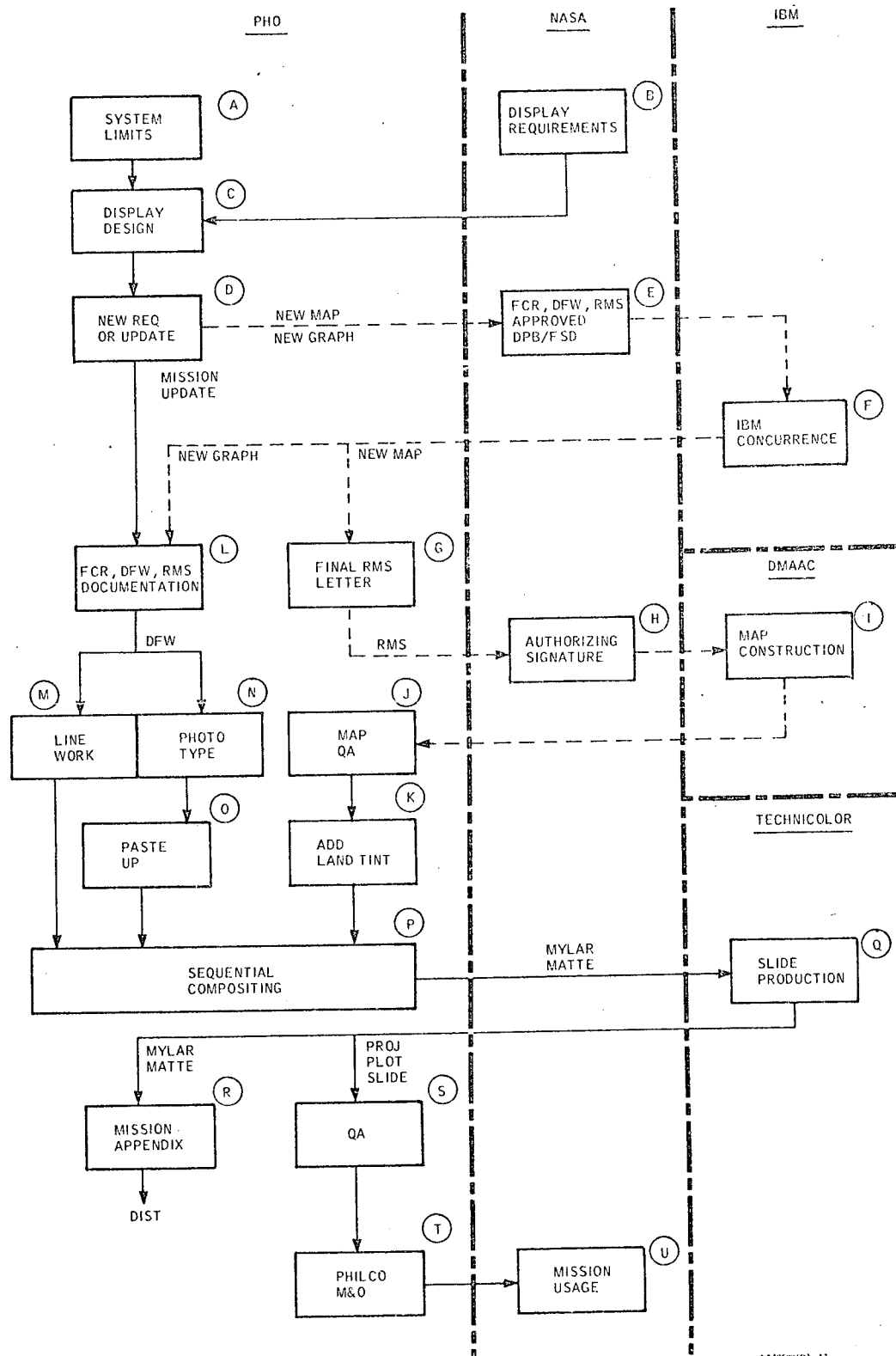


Figure 4-2 Projection Plotting Display Format Organizational Interfaces

- C. The Philco display format engineer prepares the detailed display specification including the reference map specification (RMS) and display format worksheet (DFW).
- D. During design and specification of the format, the engineer determines the new map or graph requirements. If new maps are required, an RMS and DFW are prepared. If only a new graph is required, a DFW is prepared. All new requirements are forwarded to FSD, DPB for approval and coordination with IBM programmers. Mission update requirements are received directly from the MPAD. Most updates relate to nominal or limit curves on the display graphs. They do not normally change any program parameters and thus do not require coordination with IBM.
- E. The FCR, RMS, and DFW are reviewed and approved by the DPB and forwarded to IBM for cognizant signatures.
- F. After IBM programming concurrence, the specifications are given final approval by DPB and returned to Philco for implementation and publication.
- G. The DFE prepares a letter to DMAAC detailing the RMS specifications.
- H. The RMS letter is approved and signed by the Philco NASA monitor and sent to DMAAC at MSC then forwarded to St. Louis, Missouri, for map construction.
- I. The Defense Mapping Aerospace and Aeronautical Center in St. Louis, Missouri, constructs the maps according to the RMS. Completed maps are returned directly to Philco-Ford.
- J. A careful QA inspection for optical and photographic quality and compliance with the RMS is performed on the maps when received by Philco.
- K. Land tint is added to land masses where required by means of a peel-coat mask and screen composite.

- L. The FCR, DFW, and RMS comprise the basic documentation for the projection plotting displays. The DFW becomes the primary specification source for producing the non-map portions of the display.
- M. Linework for graph grids and map graticules are cut on scribecoat using the coordinatograph.
- N. A varitype manual phototype machine is used to produce the alphanumerics for titles, scales, and map coordinates.
- O. Clear film is pin registered over a coordinate grid, and the alphanumerics are wax mounted according to the DFW coordinate specifications. The positive paste-up is then printed to produce an alphanumeric negative.
- P. A pin-registry system of sequential printing composites the linework, alphanumerics, and maps to produce a single mylar matte film in positive form. At this point, a DFE makes a final check for accuracy and quality.
- Q. The mylar matte is received by the Technicolor precision slide lab, photo-reduced, and metal etched on a projection plotting slide.
- R. The mylar matte is returned to Philco, copied, reproduced, published in the mission appendix, and distributed as the final documentation for the displays.
- S. The projection plotting slides are received from Technicolor, carefully inspected for quality, and delivered to the Philco M&O.
- T. Philco M&O loads the projection plotting slide in the projection cassettes according to mission phase.
- U. Final utilization by NASA FCD occurs during mission operations.

4.3 IDENTIFICATION

Identification of projection plotting formats is required both for computer callup operation and for control and reporting during various stages of development. Three separate numbers must be identified for projection plotting formats.

- A. Manual Select Keyboard Number. The projection plotting displays are identified by an MSK number which may or may not appear on the background and is not generated dynamically as for D/TV displays. The MSK number must appear on the basic projection plotting DFW.
- B. Format Control Number. The alphabetic prefix for projection plotting formats designates the mission program used. The 4-digit serial number is used to identify individual background slides.
- C. Slide Position. In addition to the FCN, a slide position number (0 through 39) must be identified on the DFW for each projection plotting display. Selection of slides within a cassette is by position since no coding is available on the slide-mounting frames. Cassettes may be changed between mission phases to provide additional display backgrounds; therefore, slide positions are sometimes duplicated.

4.4 DISPLAY EQUIPMENT

4.4.1 General

Selection of projection plotting displays is initiated by the computer program. Scribing, spotting, and static slide projectors are individually controlled by the program. Manual control is limited to the selection of blank slides for rescribing dynamic data and the opening and closing of projector shutters. Selection of slide combinations within a display is made from the operations control console via MSK requests.

4.4.2 Background Projector

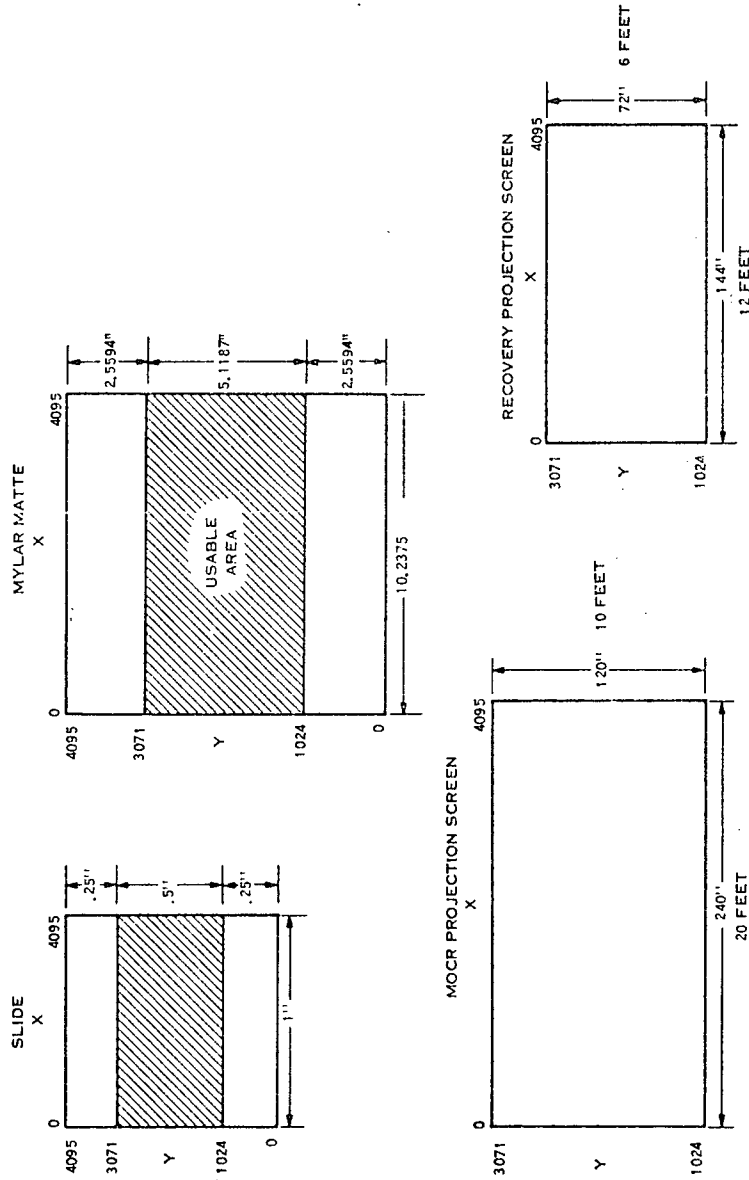
The static slide projector is a background or reference projector which places a map, graph, or other static image on the display screen. The image is in negative form with white lines and characters on a black background. The projector contains color filters, and the image can be projected in red, blue, cyan, magenta, yellow, or green. A slide carousel capable of holding from 1 to 40 slides is mounted above the projector and can be removed and replaced in less than 1 minute. Slides may be selected in random order under computer program control. Figure 4-3 illustrates the dimensional relationships between slide, mylar matte, and projection screen.

4.4.3 Scribing Projector

The basic elements of a scribing projector are shown in Figure 4-4. The scribing projector contains the same complement of color filters as the background projector, and the magazine capacity is 1 to 40 opaque slides. A 4096 X 4096 matrix is used to locate, by X-Y coordinates, any point or symbol which is to be scribed.

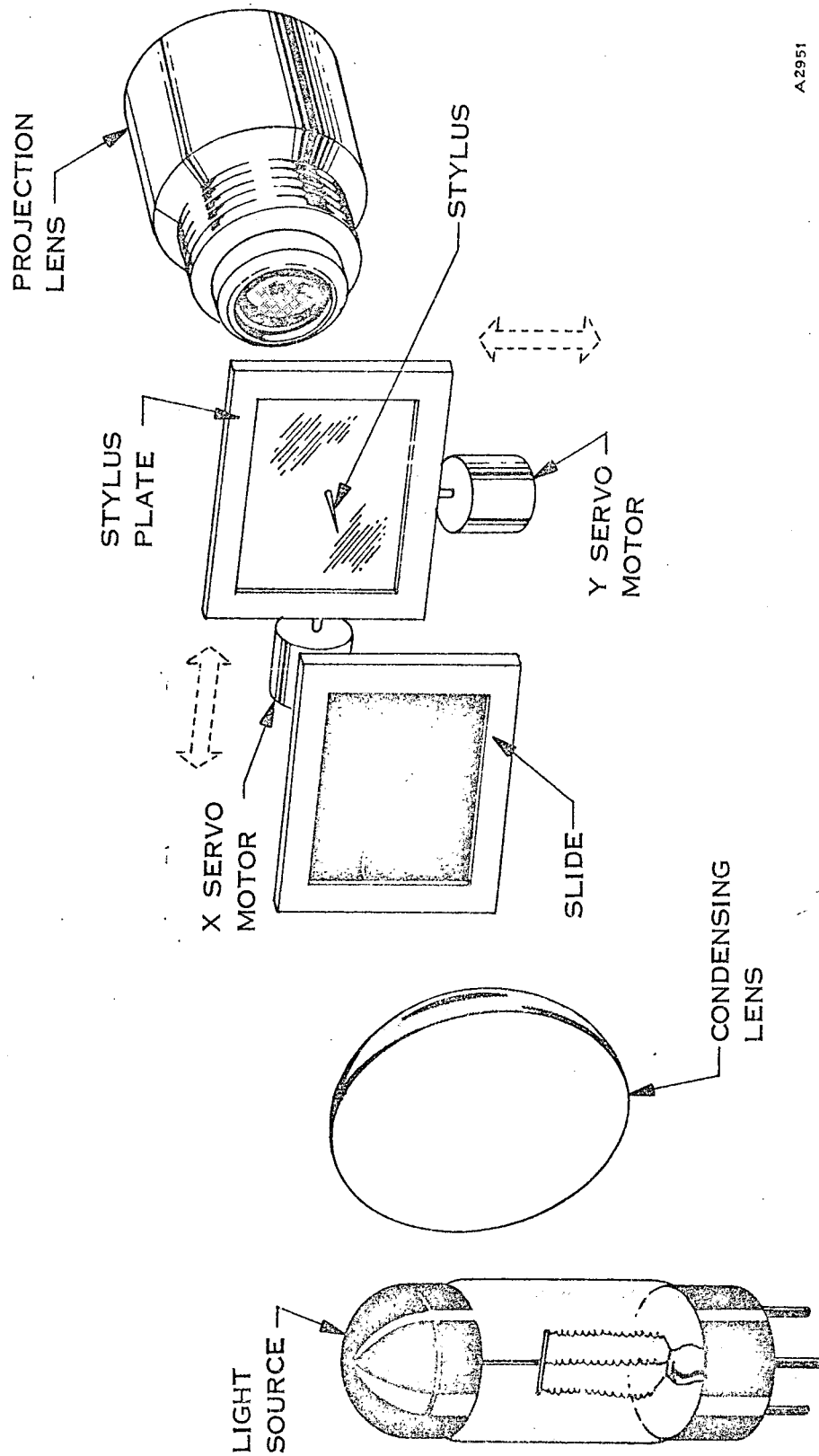
Computer instructions are transmitted from the RTCC to the projection control equipment and converted into X-Y deflection signals. The signals are applied to servo motors driving a clear glass plate with a stylus mounted in its center. The stylus plate is moved forward bringing the stylus into contact with the opaque slide. The stylus scribes on the opaque slide allowing light to pass through the scribed area to the projection screen. A typical example of information that might be scribed would be the present and the next two groundtracks of a space vehicle.

From 1 to 63 alphanumerics and special symbols may also be scribed dynamically. This is controlled by logic cards contained in the projection control equipment. There are one or more cards for each of the symbols. Each card generates coordinates for a series of points which when plotted in order cause symbols to appear in the location desired on the viewing screen. For example, if the logic card containing the points for the letter "A" were addressed, the symbol would be scribed on the opaque slide in the following 1, 2, 3, 4 order.



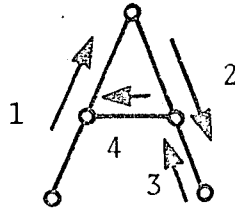
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Figure 4-3 Slide, Mylar Matte, and Display Screen Relationship



A2951

Figure 4-4 Scribing Projector Elements



The character is centered about an X-Y coordinate contained in the data word. There is no typewriter mode. The 63 alphanumeric and special symbols are shown in Figure 4-5. Character height may be 2, 3, 4, or 5 percent of display height.

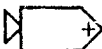




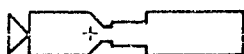






4.4.4 Spotting Projector

The spotting projector is similar in operation to the scribing projector. The opaque slide and stylus plate are replaced by a special slide containing four symbols. Any one of the four symbols may be selected and its image projected on the viewing screen in terms of X-Y coordinates. Movement of the spotting slide by the servo motors is under computer program control. The symbols available are shown in Figure 4-6.

00	○	20	+	40	—	60	◦
01	1	21	A	41	J	61	∅
02	2	22	B	42	K	62	S
03	3	23	C	43	L	63	T
04	4	24	D	44	M	64	U
05	5	25	E	45	N	65	V
06	6	26	F	46	O	66	W
07	7	27	G	47	P	67	X
10	8	30	H	50	Q	70	Y
11	9	31	I	51	R	71	Z
12	a	32	.	52	q	72	△
13	b	33	g	53	r	73	☆
14	c	34	h	54	s	74	/
15	d	35	i	55	t	75	ω
16	e	36	m	56	u	76	λ
17	f	37	n	57	v	77	

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Figure 4-5 Projection Plotting Character Set

SCREEN SIZE	SYMBOL NAME	SYMBOL	SLIDE POSITION	MYLAR MATTE DIMENSIONS
RECOVERY 6 X 12	COMMAND AND SERVICE MODULE		1	L = 0.157 W = 0.050
	IMPACT PREDICTION		2	DIA = 0.065
	CSM/OWS		3	L = 0.300 W = 0.070
			4	
	ALIGNMENT SPOT		5	DIA = 0.065
MOCR 10 X 20 SPOTTER ≈1	COMMAND AND SERVICE MODULE		1	L = .355 W = .140
	CSM/OWS		2	L = .600 W = .095
	IMPACT PREDICTION		3	DIA = .086
	SIVB		4	L = .600 W = .144
			5	
MOCR 10 X 20 SPOTTER ≈2	COMMAND AND SERVICE MODULE		1	L = .355 W = .140
	ORBITAL WORKSHOP		2	L = .600 W = .188
	IMPACT PREDICTION		3	DIA = .086
	SIVB		4	L = .600 W = .144
			5	

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Figure 4-6 Spotting Projector Symbols

4.5 DISPLAY DESIGN

4.5.1 General

The design of projection plotting formats requires an understanding of the fundamental display principles outlined for formats. Projection plotting formats are most commonly a combination of maps and graphs. Maps used for projection plotting are produced by the Defense Mapping Aerospace & Aeronautical Center (DMAAC) in St. Louis from reference map specifications (RMS). All such maps are supplied in negative form on stable base film suitable for the photocompositing process and are unique in their simplicity. Features found on most maps such as political boundaries, lakes, cities, and streams are reduced to a minimum or completely eliminated. Such simplification provides for minimum confusion when the map background is overlaid with groundtracks, recovery area ellipses, or spotting symbols. A modified cylindrical projection (equal latitude, equal longitude) is used to simplify programming within the 4096 X 4096 area of the display.

The requirements for projection plotting formats are produced in three parts. The first is the RMS directing the construction of the map to be used for a particular format or series of formats. The second part, the display requirement, describes on a DFW form the requirements for each initial display. The third part, the mission appendix, contains reproductions of the mylar mattes actually used in making the background slides for each mission.

4.5.2 Reference Map Specification

Figure 4-7 shows a typical RMS for the MOCR 10 X 20 foot screen. The RMS supplies the cartographer with the specific information necessary for developing the maps required for the projection plotting displays. The items specified are defined as follows.

- A. Map Format. Gives two types of information. (Not to be confused with display format.)
 - 1. Map Area. Defines the total display area allotted for the map. This includes the graticule values, titles, etc.

- A. MAP FORMATS: SP0003/0055, SP0043/0150
- MAP AREA - 10.24" X 3.39"
 - MAP IMAGE AREA - 9.63" X 2.95" (SEE FIGURE 2-1)
 - (1) 0.3" MARGIN ON E AND W
 - (2) 0.19" MARGIN ON N AND S
- B. PROJECTION: EQUAL LATITUDE, EQUAL LONGITUDE SPACING
- C. GRATICULE
- WORLD MAPS - 10-DEGREE LINES (0150)
 - ABORT MAPS - 5-DEGREE LINES (0055)
- D. FEATURES
- SHORELINES
 - NO LAND TINT
- E. LINE WEIGHTS
- SHORELINES - 0.075"
 - GRATICULE - 0.005"
 - BORDER - 0.005"
- F. REMARKS
- NO LAKES
 - NO POLITICAL BOUNDARIES
 - NO GRATICULE VALUES
 - 5-DEGREE TICKS ALONG BORDER ONLY
 - NO COUNTRY NAMES
- G. SHEET TITLES
- APOLLO ABORT I & II - 0055
40N - 5S 85W - 5E
 - APOLLO ABORT III & REENTRY - 0150
40N - 40S 95W - 95E

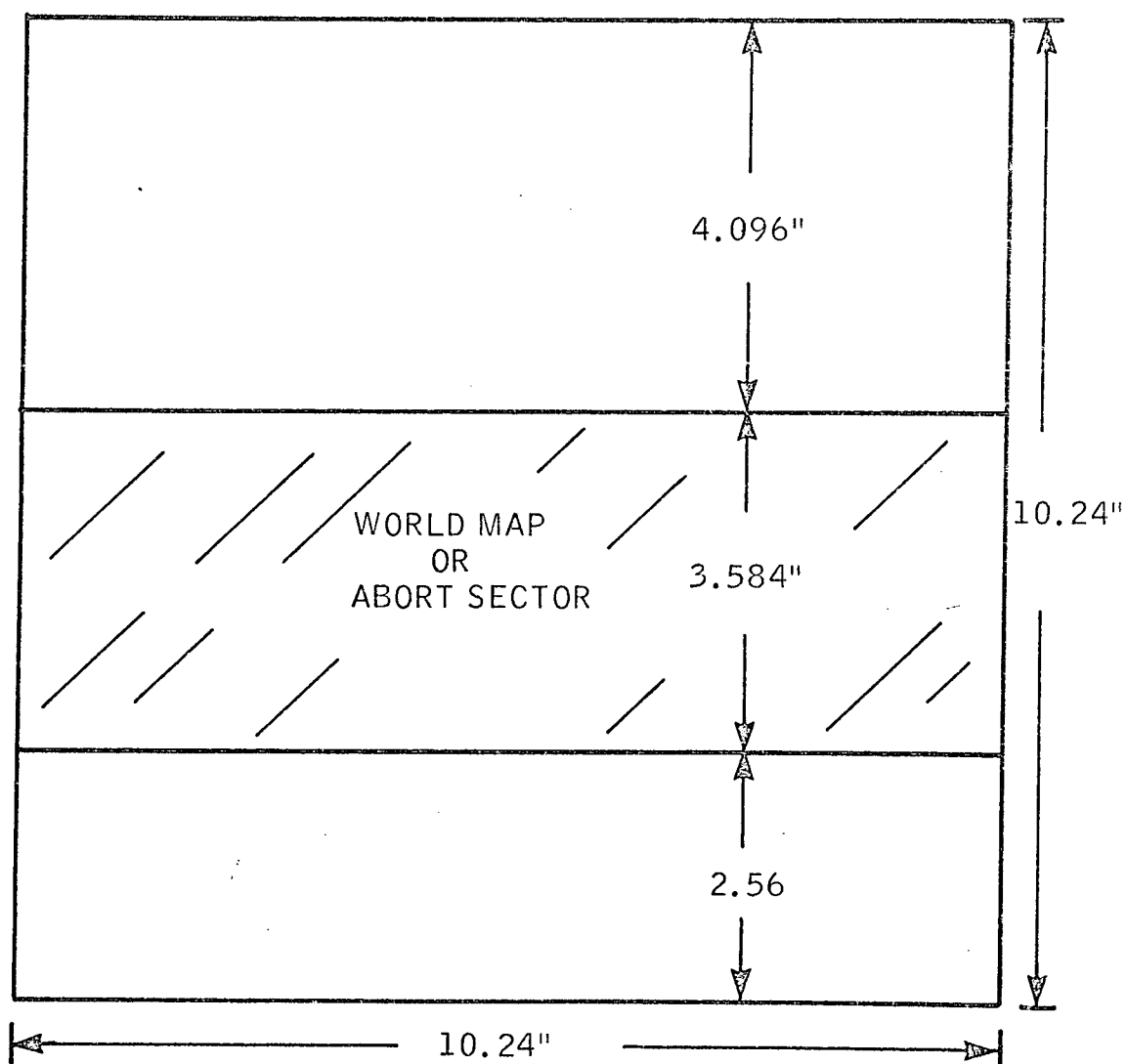
Figure 4-7 Reference Map Specification (1 of 2)

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H. MAP BOUNDARIES

	LAT AT TOP	LAT AT BOTTOM	LONG AT LEFT	LONG AT RIGHT
0055	40° N	5° S	85° W	5° E
0150	40° N	40° S	95° W	95° E

I. MAP PLACEMENT



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Figure 4-7 (2 of 2)

2. Map Image Area. Defines the area (in inches) containing the geographical features of the map.
- B. Projection. Refers to the method used in transferring a curved surface to a plane surface. The procedure specified by the PHO Display Design Section is the equal latitude, equal longitude form of projection.
- C. Graticule. Denotes a grid formed by lines of longitude and latitude.
- D. Features. Refers to characteristics such as shorelines, mountains, colors, shading, and alphanumerics which are to be included in the map.
- E. Line Weights. Refers to use of line widths required for each feature, particularly if other than those specified in PHO-SP03535.
- F. Remarks. Includes any additional instructions necessary to have the map constructed as desired.
- G. Sheet Titles. Defines the sheet title placed outside the image area. The sheet title uniquely identifies each map that is ordered by phase, latitude, longitude, and format number (MSK).
- H. Map Boundaries. Defines the map boundaries in terms of latitude and longitude. These are given for the top, bottom, left, and right.
- I. Map Placement. Indicates the exact location for placement of the map area on the 4096 X 4096 matrix area of the mylar matte. The placement diagram, referenced to the display area dimensions, also shows the location of the map area in inches.

It should be noted that maps are supplied by ACIC without land tint or graticule lines. These items are constructed by PHO and added during photocompositing of the mylar matte.

4.5.3 Projection Plotting Display Format Worksheet

- A. Coordinate Systems. A 4096 X 4096 matrix is used to locate, by X-Y coordinates, any point or symbol to be scribed and projected on the viewing screens. A matrix of the same aspect ratio (1:1) was used as the foundation of the projection plotting DFW's to simplify computer programming and mylar matte development.

The development of the precision mylar matte is thus directly related to the method used by the computer to address a specific location on the display screen. The X-Y computer address is a discrete value between 0 and 4905 in both X and Y coordinate directions. It is possible to directly convert this X-Y address into inches on the mylar matte by letting one X or Y increment between coordinate locations equal a simple decimal fraction. Thus, if an increment of X or Y is 0.0025 inch, then the area to be drafted would have the dimension 10.2375 inches X 10.2375 inches. A point 2000 X increments from the left side of the mylar matte would correspond to exactly 5 inches.

- B. Projection Plotting DFW. The principle features of the DFW (refer to Figure 4-8) are as follows:
- The DFW display area is 1.5 times larger in size than the corresponding mylar matte display area.
 - Only the useful display area is shown in the vertical direction (Y coordinates 1024 to 3071).
 - Each X or Y increment equals approximately 0.00375 inches.
 - Border ticks are included to assist in drawing the display.
 - Major ticks are every 100 increments.
 - Minor ticks are every 10 increments.
 - The title block shows title, comments, and map tint.

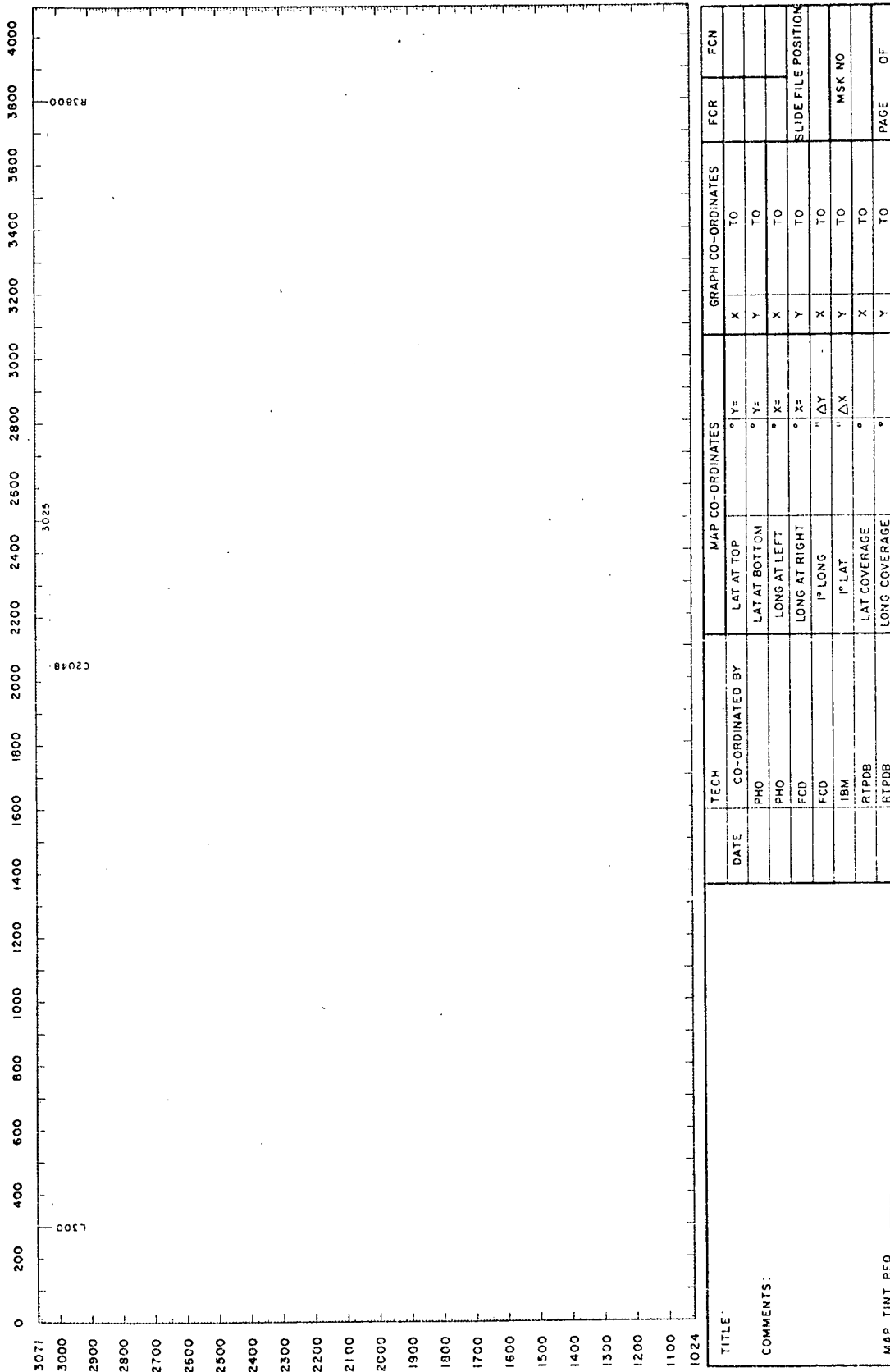


Figure 4-8 Projection Plotting DFW

- The map coordinates correlate with the reference map used.
- Graph coordinates define the graph dimensions appearing on the display.
- An identification block is provided for MSK, slide file position, FCR, and FCN numbers.
- A coordination signature block is provided for cognizant signatures.

4.5.4 Documentation

The specification for each projection plotting display format is approved by NASA, published, and then distributed to cognizant personnel. Publication documents and establishes the requirement for production of the display. The following items are published in PHO-TR485B, Volume II.

- A. DFW. The DFW shows the basic arrangement or layout of each PP format. Map or graph plotting limits are specified in the title block. Data which is characteristic of a particular mission, such as recovery areas, contingency lines, etc., is not shown but is included in the mission appendix.
- B. RMS. The RMS specifies the information needed by DMAAC for construction of background maps.
- C. FCR. The FCR provides a signature approval block and justification for each new or changed display.
- D. Mission Appendix. Reproductions of the approved mylar mattes are published for each mission. Each one shows the final format configuration for that mission with all data necessary to supplement the basic specification.

4.6 MYLAR MATTE PRODUCTION

4.6.1 General

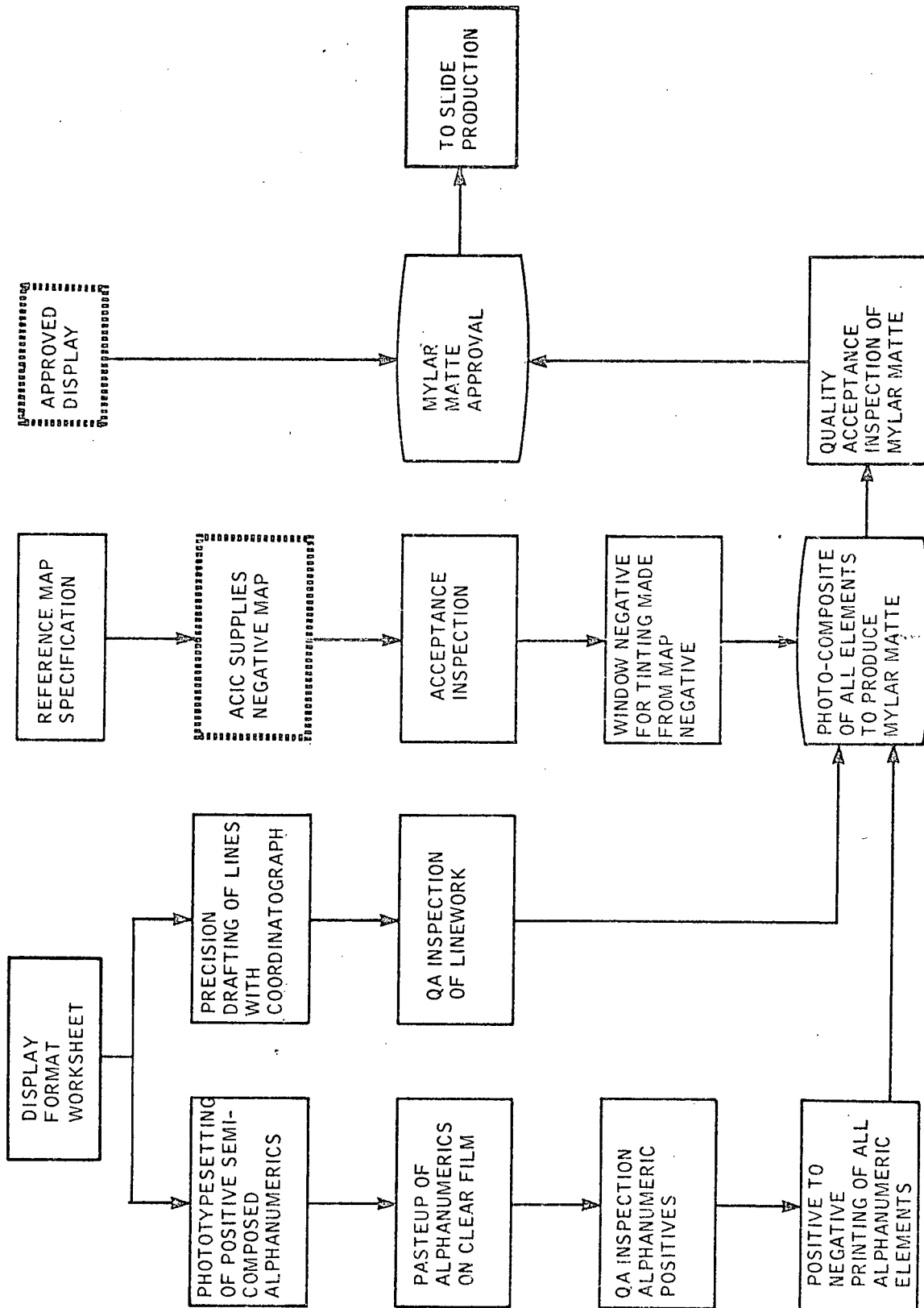
Production of the projection plotting mylar matte involves three parallel processes followed by an end process compositing the results of the first three processes. The term mylar matte refers to the positive copy, commonly called "artwork," which is photographically reduced to the size used in printing the projection plotting slides.

The typical format for projection plotting displays includes a map. A negative of the required map is furnished by NASA through DMAAC. All other maylar matte elements are supplied by PHO.

The DFW and RMS is the controlling document used in producing the artwork elements termed alphanumerics, linework, and reference map. The following paragraphs and Figure 4-9 outline these processes.

4.6.2 Alphanumerics

- A. Standards. Standards have been developed for alphanumerics and linework as a result of experience and empirical investigation. The following items summarize these criteria as they apply to projection plotting mylar mattes.
- Alphanumerics for MSK, FCN, and map image area are 7 point for the 10 X 20 and 6 point for the 6 X 12.
 - Alphanumerics for graph scales and area outside map image are 9 point for the 10 X 20 and 7 point for the 6 X 12.
 - Minimum clearance between alphanumerics and lines is 0.025 inch.
 - MSK ID goes in upper right corner.
 - FCN ID goes in upper left corner.
 - Title goes in top center.



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Figure 4-9 Mylar Matte Production Steps

- B. Pasteup. Alphanumeric typeset is composed on the varityper on positive film which is then waxed. Pasteup consists of pin registration of a clear sheet of film over reference coordinate sheets, and the cutting out and mounting of the typeset copy line-by-line or character-by-character according to the coordinates specified on the DFW.
- C. Quality Acceptance Inspection. At this point a very careful quality acceptance check is made for completeness and accuracy of the alphanumerics, as well as for correct positioning on the typeset positive.
- D. Negative Printing. The completed typeset positive is pin registered to stable base low-speed film, printed in negative form, and developed with high contrast developers. The resulting typeset negative is then the alphanumeric element to be used in compositing the mylar matte.

4.6.3. Linework

- A. Precision Drafting. Following the coordinates specified on the DFW, lines are scribed with a coordinatograph on a stable base scribecoat film. Scribecoat sheets are punched for pin registration prior to scribing so that all lines may be exactly registered to the referenced pinhole. When scribing of linework is completed, the resulting pin-registered scribecoat constitutes one of the negative compositing elements. Graph and map graticule line weight standards are 0.005 inch.
- B. Quality Acceptance Inspection. A careful inspection of the scribecoat is made upon completion. Critical to acceptance for compositing are correct line weight and position, cleanliness of scribed cuts, square corners, and film base freedom from cuts, gouges, and scratches.

4.6.4. Reference Maps

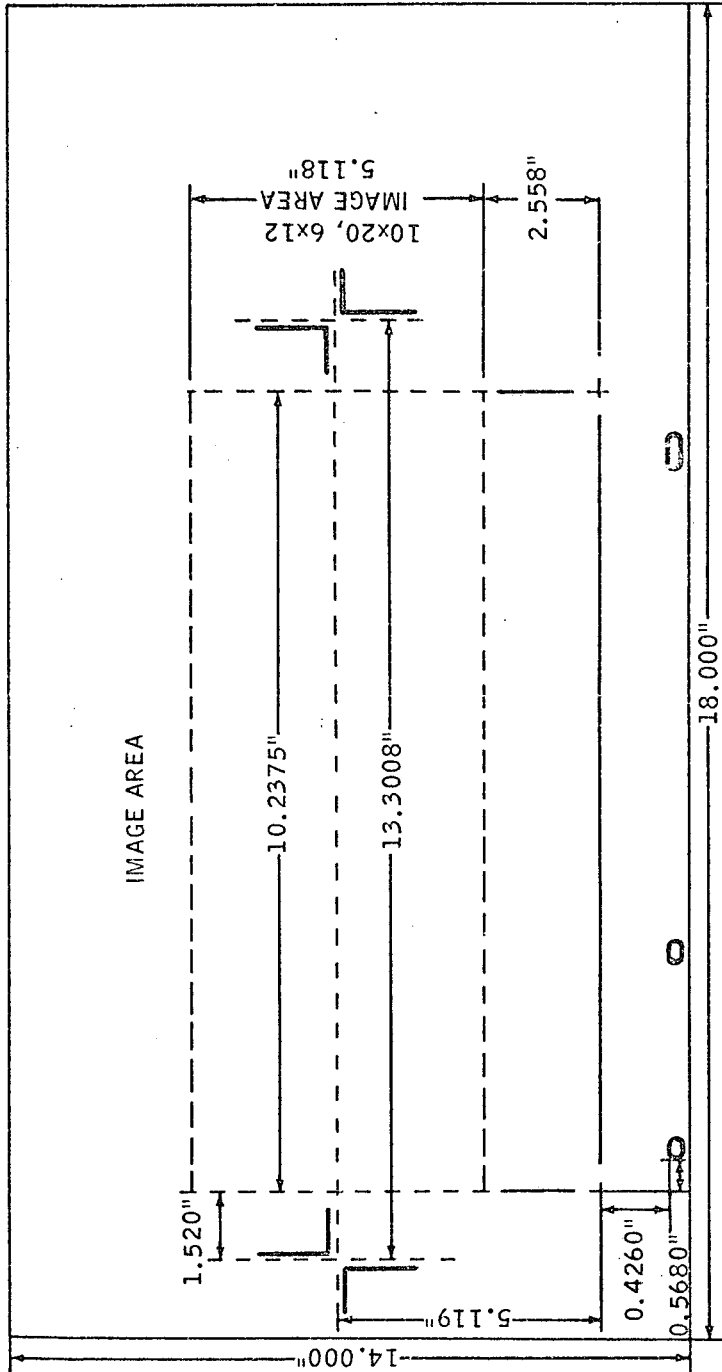
- A. Acceptance Inspection. Using the reference map specification, the DMAAC constructs a modified cylindrical projection map with the required coverage and physical dimensions.

This map is supplied on stable base film in negative form. A careful inspection of each map received is made for conformance to the Reference Map Specification. Checks are also made for density, line acuity, and general photographic qualities.

- B. Tinting Window Negative. Many projection plotting displays require that a clear distinction be made between land masses and oceans. The distinction is accomplished by tinting the land masses with a random texture pattern of fine lines. The map negative is used to produce a window negative for the land masses. Then, when the final mylar matte is being composited, the window negative (in combination with a texture pattern) becomes one of the exposed elements. The resulting pattern or tint distinguishes land areas from water areas.

4.6.5 Photocompositing

- A. Exposure. The projection plotting mylar matte is a positive photocomposite of all elements required to produce the display background. Elements normally included in the sequential pin-registered printing process are the linework, alphanumerics, slide reduction fiducials, reference map, and land mass tint pattern. Figure 4-10 shows the relationship between the slide fiducials, image areas, and pin-registration holes. Sequential exposure of each element is made with a point source light. Exceptional care and cleanliness is required due to the critical nature of the mylar matte positive and the great demand for resolution in the projection plotting display system.
- B. Quality Acceptance Inspection. After compositing, a careful inspection is made for conformance to technical requirements for slide making. Line acuity, dimensional accuracy, land pattern density, opaque area density, emulsion flaws, and scratches within clear areas are critical for projection plotting formats.

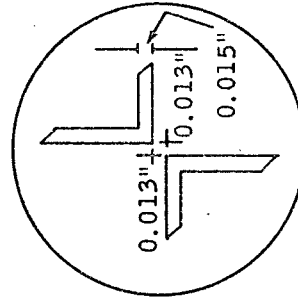


SPECIFICATIONS FOR PROJECTION PLOTTING MYLAR MATTE:

SLIDE FIDUCIALS

PIN BAR REGISTRATION HOLES

FILM BOUNDARIES



FIDUCIAL DETAIL

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Figure 4-10 Relationship between Slide Fiducials, Image Area, and Pin Bar Registration Holes (Projection Plotting Mylar Matte)

4.6.6 Mylar Matte Approval

The DFE checks the completed mylar mattes for accuracy of alpha-numerics, linework, and conformance to display requirements. Approved mylar mattes are signed by the DFE and taken to the slide laboratory.

A critical inspection is made on a light table by visual comparison with standard criteria. Checks are made for linebreaks, scratches, dirt, inconsistent linework, and density. The FCN and MSK are checked against the incoming route sheet and interoffice correspondence (IOC) to establish identity. Land pattern density must be between American Standards Association (ASA) 0.24 and ASA 0.34 as compared with a standard density pattern. Minimum line weights must be at least 0.0025 inch. A visual comparison check with a standard mylar matte artwork is made for the following:

- Graticule and graph line weight
- Fiducial placement
- Image area corner ticks for dimensional accuracy and alignment (± 0.002).

4.7 SLIDE PRODUCTION

4.7.1 General

The projection plotting display system requires a specialized high-resolution slide suitable for 240 times magnification and capable of withstanding the intense heat from the projection lamps.

These slides are produced in the NASA Precision Slide Laboratory by Technicolor Corporation in accordance with Philco Display Design Section requirements.

4.7.2 Production

The mylar matte is forwarded to the Technicolor slide lab where it is photographically reduced and two precision slides made for each format. PHO-IM227 contains a detailed step-by-step description of the equipment and photographic processing required.

4.8 QUALITY ACCEPTANCE INSPECTION

Careful checks are made of each slide delivered by the slide lab to ensure quality and accuracy. A discretionary optical inspection is followed by an operational check on the projection equipment. Failure of the operational check requires the detailed optical inspection to identify the nature of any flaws.

A. Optical Inspection. The completed slide is quality checked microscopically. A careful comparison under high magnification is made between each completed slide and the mylar matte to assure complete accuracy of reproduction. The following criteria govern slide quality acceptance:

- No more than three line breaks per slide with maximum size 0.00025 inch
- Each line does not vary in excess of 10 percent from nominal weight

- Clear etched image areas shall have less than 0.1 ASA density
 - Land pattern density is greater than ASA 2.72
 - Land tint shall retain the same relative density as the mylar matte
 - All pinholes shall be less than 0.0001 inch in diameter
 - Maximum of two pinholes within any 0.25 inch square area.
- B. Operational Inspection. A final check of the image is made by projecting the slide on the operational projection equipment and monitoring for any undiscovered flaws. In addition to overall image quality, the alignment and placement accuracy must be ± 0.25 inch.

The accepted slides are then ready for mission loading. One of the two slides made for each operational display is maintained in a spares file for immediate access in the event of slide failure during mission operations.

SECTION 5

PEN RECORDER OVERLAYS

5.1 GENERAL

Pen recorder overlays are provided in two formats: individual chip overlays and strip overlays. The chip overlays fit into a holder, on each chart recorder, over the pen whose analog record is to be identified. The strip overlays are a composite of eight chips on a single clear film strip which is taped or placed over the chart record to be identified. In addition to the composited chips, there are titles and spaces for header information, time references, and bilevel records.

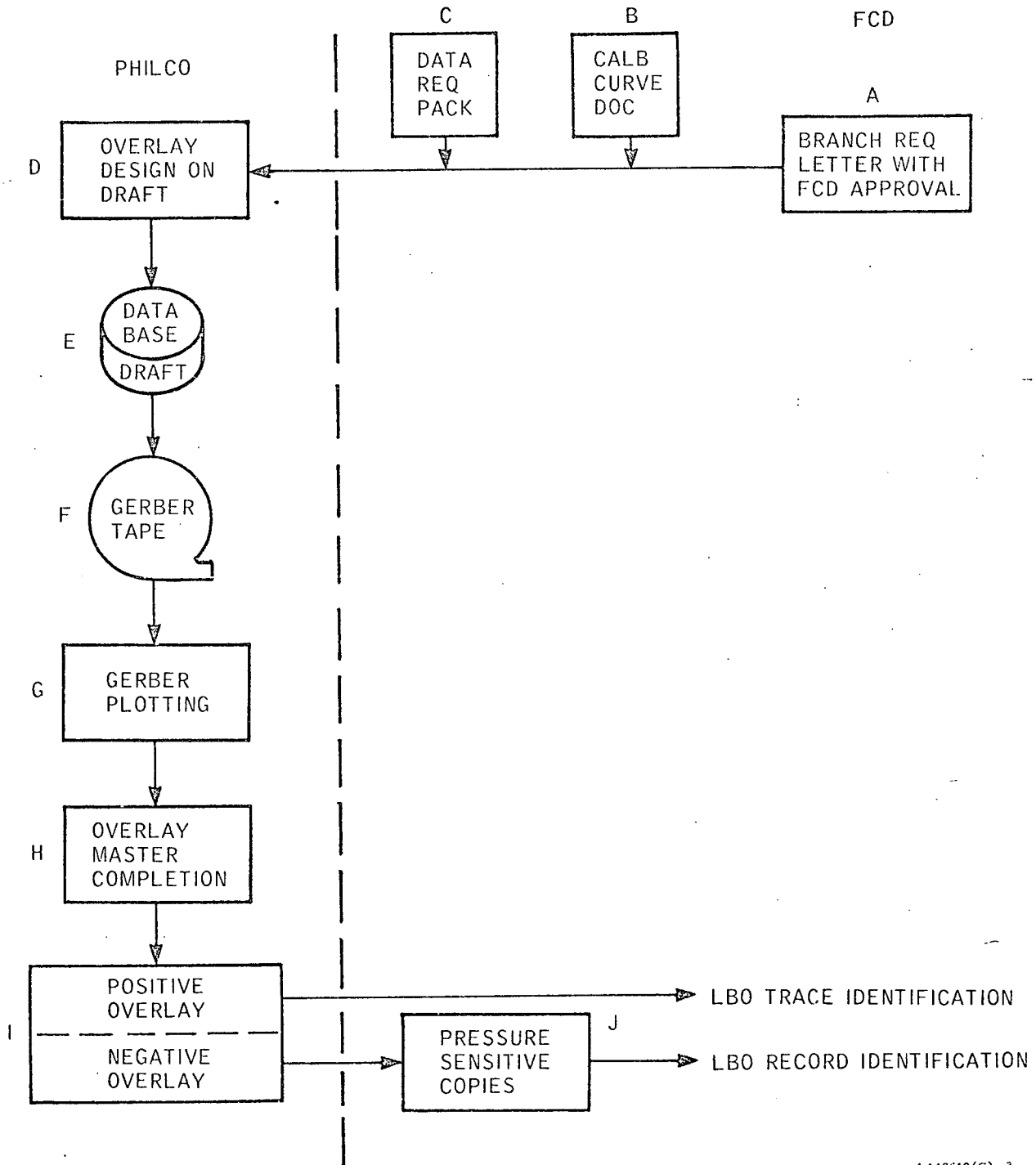
The clear film chips and strips carry titles, measurement numbers, engineering unit scales, and PFS scales.

Printed pressure-sensitive copies of strips and individual chips are provided for attachment to retention records, when requested.

5.2 FUNCTIONAL FLOW

The following paragraphs and Figure 5-1 outline the organizational interfaces and functional steps in production of pen recorder overlays and pressure sensitive copies.

- A. The Flight Control Division approves branch requirements and forwards them by letter to the Flight Support Division and Philco. The requirements identify the delivery dates, number of copies, user console numbers, and telemetry measurement numbers.
- B. The Flight Control data requirements package provides information on pen position, identifying titles, and deflection.
- C. The *Operational Calibration Curve Document* is the source for correct calibration data for each analog input.



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Figure 5-1. Pen Recorder Functional Flow

- D. Using DRAFT display design capabilities, a stored basic format, and the requirements and calibration data, a chip display is organized containing lines, alphanumerics, and scales.
- E. Six completed chip designs are stored as a single display on the DRAFT data base disc pack.
- F. Chip displays are converted to Gerber tape outputs when design is completed.
- G. The chip displays are plotted on positive mylar film on the Gerber at the scale factor required to produce the final overlay size.
- H. After Gerber positive processing, the chips are separated, if necessary, and organized into the required strips or chip groupings with the appropriate standard header labels. Negative prints are made of this composite in order to produce overlay masters.
- I. Positive and negative overlay copies on film are made. Positive copies are trimmed to size and delivered as the completed chip or strip overlay. Negative copies are forwarded for printing of the pressure sensitive labels.
- J. Pressure sensitive copies are printed at 1:1 size and are delivered, on receipt, for usage in identifying the permanently retained recorder records.

5.3 PEN RECORDER

Each stripchart recorder produces 17 ink traces on chart recording paper. A complete set of traces consists of eight analog traces alternating with bilevel and time traces. The mylar film overlay is positioned over the exit port where the paper emerges from the recorder on its way to the take-up reel. The eight analog traces are identified from left to right with pen location numbers 1 through 8.

5.4 REQUIREMENTS

The combined requirements for formatted overlays are received by Philco-Ford from the NASA Flight Control Division office and consist of separate requirements from each FC branch. Each branch requirement specifies the high-speed formats, subformats, and MED groups which have overlay requirements, the *Operational Calibration Curve Document* change number that is to be used for the engineering unit scaling, the number of copies of overlays or pressure sensitive prints, and the desired delivery date. The *Flight Control Data Requirements Document* lists the high-speed format, subformat alphanumeric titles, measurement numbers, and pen locations for all stripchart recorders.

The *Operational Calibration Curve Document* contains laboratory test and calibration data for each transducer in the vehicle. A calibration curve plotted in engineering units versus oscillator voltage (stimulus) and percent full scale is included.

5.5 DRAFT DISPLAYS IDENTIFICATION

Identification of stripchart pen recorder displays within the DRAFT system is by MSK only. The FCN and PCL are always 0000 and blank, respectively.

5.6 OVERLAY CHIP AND STRIP ID

Each chip overlay is identified by its measurement number and option, if any. The DRAFT MSK number is entered on the upper right of the label area as a reference to the DRAFT display library. A complete cross-reference list by measurement number

and MSK is also maintained which shows right (R) and left (L) deflection for the chip. Chips and their cross-reference lists are identified by header information which includes mission, vehicle, and console numbers. Spaces are included in the header area for event, start and finish times, data format numbers, chart speed, and operator initials. A cross-reference list identifies mission, console numbers, right and left deflection, and measurement numbers on each strip.

5.7 OVERLAY DESIGN

5.7.1 General

Overlay design is accomplished in three steps: 1) extraction of the required subformat data, alphanumeric titles, and measurement numbers; 2) entry of the calibration curve engineering range units in DRAFT to produce the scales; and 3) addition, at the DRAFT console, of the overlay identifiers, alphanumerics, and scale to each basic format chip.

5.7.2 Pen Recorder Basic Format

The stripchart basic format contains the data common to each pen recorder chip. Data is entered for six chips on each DRAFT display. Figure 5-2 illustrates the chip formats as they appear on the screen. The character size and dimensions on the display monitor take into consideration the final output required and the Gerber plotter scaling factors which are required. The typed dimension figures have been added to show 1024 X 1024 DRAFT coordinate positions for the common data. Analog parameters are plotted in each chip area against the 0-100 PFS at the top of the overlay.

5.7.3 Data Entry

Selection of data is made according to the flight control overlay requirements. Using the requirements list, the alphanumerics of each overlay chip are extracted from the Flight Control data pack. Scale data is extracted from the *Operational Calibration Curve Document* and converted by the DRAFT program to the proper 1024 coordinates on each chip of the DRAFT basic format.

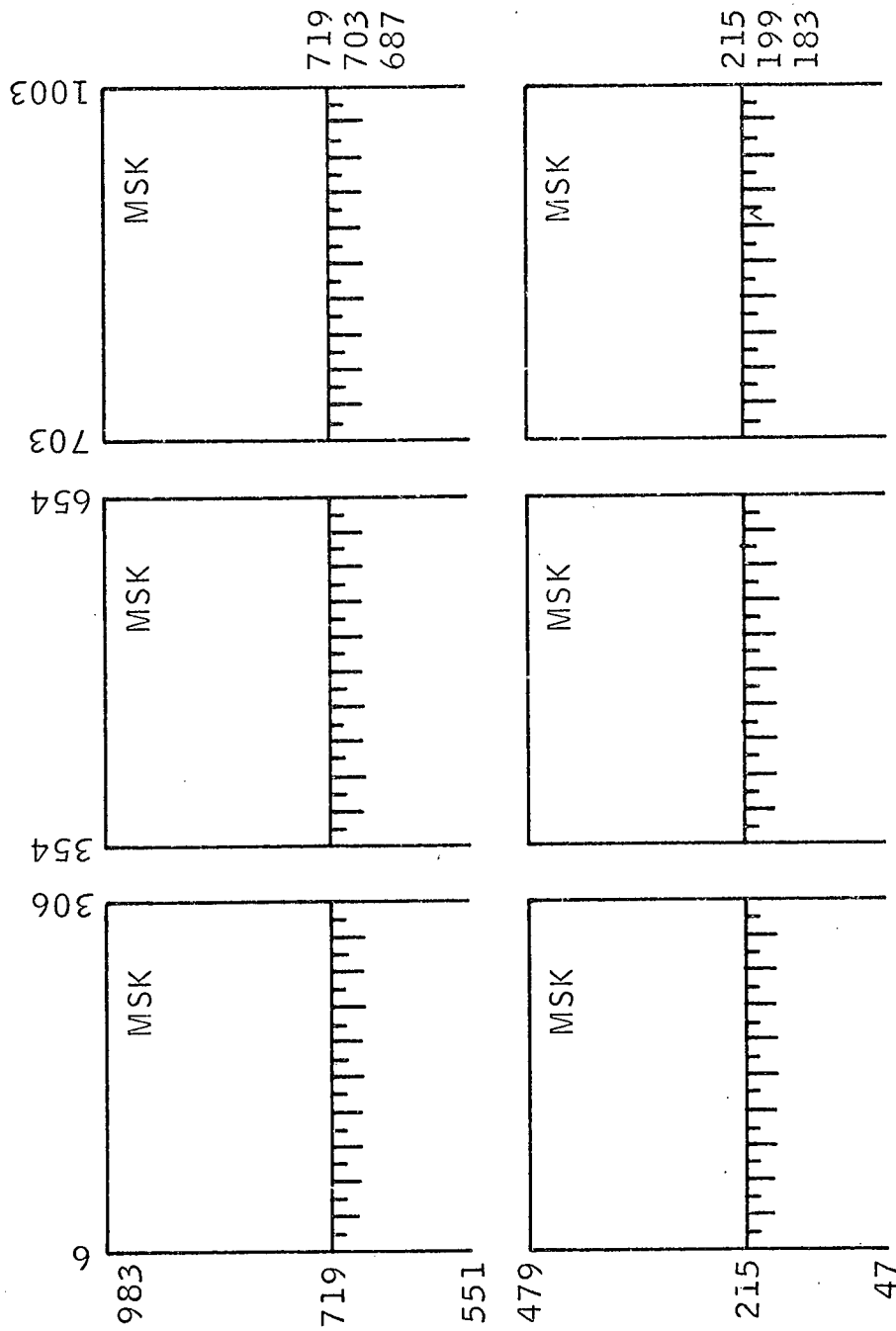


Figure 5-2 Pen Recorder Basic Format

5.8 GERBER SCALE FACTORS

The DRAFT output to the Gerber produces a tape whose machine instructions are scaled to produce a D/TV mylar matte. The chip displays, therefore, must be scaled at the Gerber control panel to produce the appropriate overlay size. The following scale factors are entered from the control panel:

- X-Scale = 0.524333
- Y-Scale = 1.000000

The No. 5 aperture is selected from the control panel.

5.9 OVERLAY MASTER COMPLETION

After processing of the Gerber film positive, chips are separated and where required, organized into strips. Vehicle identifiers, mission, and console numbers are added to the header label with image transfer characters. The chips or overlay (Figure 5-3) strips are then referred to as masters and retained as permanent records. A final QA inspection is made at this point.

5.10 POSITIVE AND NEGATIVE COPIES

A positive and negative copy of each master chip or strip master is produced. The negative is forwarded for production of pressure sensitive copies. The positive is trimmed to required size and delivered as the completed overlay.

5.11 PRESSURE SENSITIVE COPIES

The overlay negative is forwarded to reproduction for printing at 1:1 size of the pressure sensitive copies. Pressure sensitive copies are delivered on receipt.

MISSION <u>APOLLO 14</u>		CONSOLE <u>34 R</u>		HSD FORMAT _____		TMGS FORMAT _____		CHART SPEED _____	
EVENT _____		TIME START _____		LIVE _____		DSE _____		TPB _____	
SLV 1-31-71		FINISH _____						ANNOTATED BY _____	
CON 1 WSK 13 D0035-414 ATT CONT HE PRESS TK 1 PSIA	CON 2 WSK 13 D0036-415 ATT CONT HE PRESS TK 2 PSIA	CON 3 WSK 14 D0261-403 COLD HE SPH PRESS PSIA	CON 4 WSK 13 D0236-403 AUB HE PNEU SPH PRESS PSIA	CON 5 WSK 13 D0177-408 EDS 1 FUEL TK ULL PRESS PSIA	CON 6 WSK 13 D0179-406 EDS 1 OXID TK ULL PRESS PSIA	CON 7 WSK 12 G0017-401 P-W RATIO CONTROL VALVE DEC	CON 8 WSK 13 D0001-401 THRUST CHAMB PRESS PSIA	TIME REFERENCE	
RANGE 40 TO 3620	RANGE 60 TO 3600	RANGE 0 TO 3600	RANGE 0 TO 3530	RANGE 0 TO 54	RANGE 0 TO 54	RANGE 0 TO 69	RANGE 0 TO 1000		
3K 2K 1K 0	3K 2K 1K 0	3K 2K 1K 0	3K 2K 1K 0	50 40 30 20 10 0	50 40 30 20 10 0	60 40 20 0	800 600 400 200		

Figure 5-3 Overlay Master

SECTION 6

LIGHT BEAM OSCILLOGRAPH OVERLAYS

6.1 GENERAL

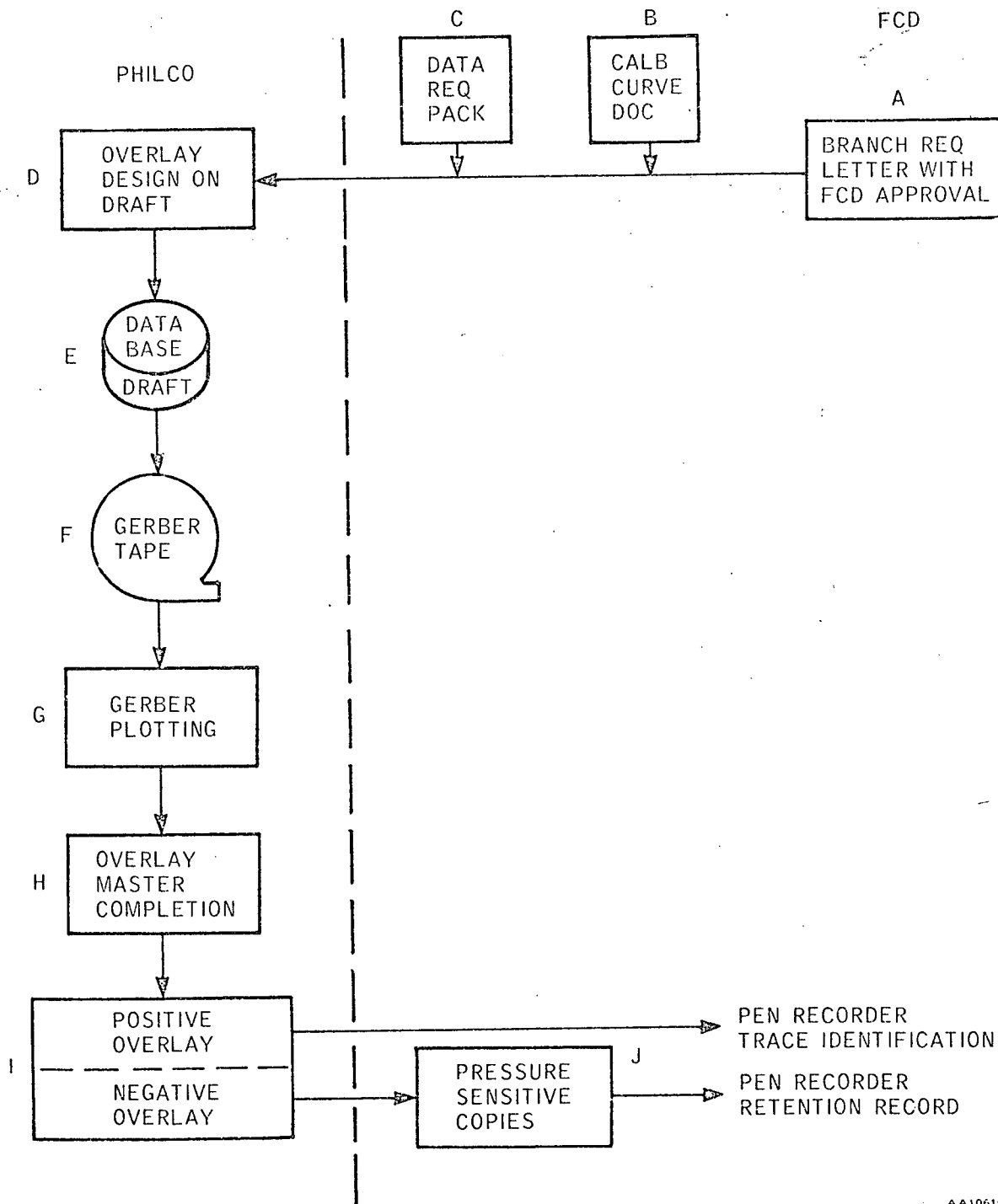
Light beam oscillographs (LBO's) record two telemetry analog parameters, two bilevel functions, and two time functions. Identification of each recorded trace is accomplished during operation with a clear mylar film. The clear film carries titles, measurement numbers, and two analog scales with engineering units. The user thus views the trace through the clear film during operation.

LBO records to be retained are identified by placing a printed pressure sensitive copy of the mylar strip on the oscillograph record. The following paragraphs define the production flow from initial requirements through development and delivery of the completed overlays and pressure sensitive copies.

6.2 FUNCTIONAL FLOW

The following paragraphs and Figure 6-1 outline the organizational interfaces and functional steps in production of LBO mylar overlays and pressure sensitive copies.

- A. The Flight Control Division approves branch requirements and forwards them by letter to the Flight Support Division and Philco-Ford. The requirements identify the delivery dates, and number of copies, using console numbers and telemetry subformat numbers.
- B. The Flight Control data requirements package provides information on pen position, identifying titles, and deflection.
- C. The *Operational Calibration Curve Document* is the source for correct calibration data for each analog input.
- D. The data for each LBO overlay is organized with converted calibration data into a completed display using DRAFT design features and a stored LBO display background containing lines, alphanumerics, and scales common to all LBO overlays.



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Figure 6-1 LBO Overlay Functional Flow

- E. Two completed LBO overlay designs are stored as a single display on the DRAFT data base disc pack.
- F. When LBO design is completed, a Gerber tape is made.
- G. The LBO overlays are plotted on the Gerber OEH plotter or COM on clear mylar film at the scale factor required to produce the final overlay size.
- H. After film processing, header labels are added to each overlay providing for entry of mission, high-speed data format, and data subformat numbers.
- I. Positive and negative overlay copies on film are made. Positive copies are trimmed to size and delivered as the completed overlay. Negative overlays are forwarded for printing of the pressure sensitive copies.
- J. Pressure sensitive copies are printed at 1:1 size and are delivered, on receipt, for usage in the NASA MCC.

6.3 LBO EQUIPMENT

Each LBO recorder produces six traces on photosensitive paper. A complete set of traces consists of two overlaid analog traces in the center with a bilevel trace and a time trace on each side. The mylar film overlay is positioned over the viewing window or taped over the exit port where the paper emerges from the recorder on its way to the take-up reel. The group of four recorders is identified from right to left as A, B, C, and D.

6.4 REQUIREMENTS

The combined requirements for formatted overlays are received by Philco-Ford from the NASA Flight Control Division office and consist of separate requirements from each FC branch. Each branch requirement specifies the high-speed formats, subformats, and MED groups which have overlay requirements, the *Operational Calibration Curve Document* change number that is to be used for the engineering unit scaling, the number of copies of overlays or pressure sensitive

prints, and the desired delivery date. The *Flight Control Data Requirements Document* lists the high-speed format, subformat alphanumeric titles, measurement numbers, and pen locations for all four LBO's. The *Operational Calibration Curve Document* contains laboratory test and calibration data for each transducer in the vehicle. A calibration curve plotted in engineering units against oscillator voltage (stimulus) and percent full scale is included.

6.5 IDENTIFICATION

6.5.1 DRAFT Displays

Identification of LBO displays within the DRAFT files is by MSK, FCN, PCL, and mission. Only the MSK and mission identifiers are used on new displays. The PCL is always blank. Changes to displays are identified by changes to the MSK and FCN. A manual cross-reference list of measurement numbers appearing on displays is maintained in MSK order.

6.5.2 Overlays

The LBO letter designator, the FC branch designator, high-speed format and subformat numbers, and mission designator uniquely identify each overlay.

The LBO letter designator precedes the oscillograph channel designator and is added in the upper left of each analog label area during DRAFT data entry. Typical entries are C09 and C10, where the C identifies the third LBO recorder from the right, and the 09 and 10 designate the analog recorder channels.

The mission number, Flight Control Branch designator, high-speed formats, and subformat numbers are entered on the overlay label area during completion of the LBO master.

6.6 .OVERLAY DESIGN

6.6.1 General

Overlay design is accomplished in three steps: 1) extraction of the required subformat data for the overlay ID, alphanumeric titles and measurement numbers; 2) conversion of the calibration curve engineering units to DRAFT input units (1024 X 1024 coordinates) and selection of EU scale numbers; and 3) addition, at the DRAFT console, of the overlay identifiers, alphanumerics, and scale to the LBO basic format.

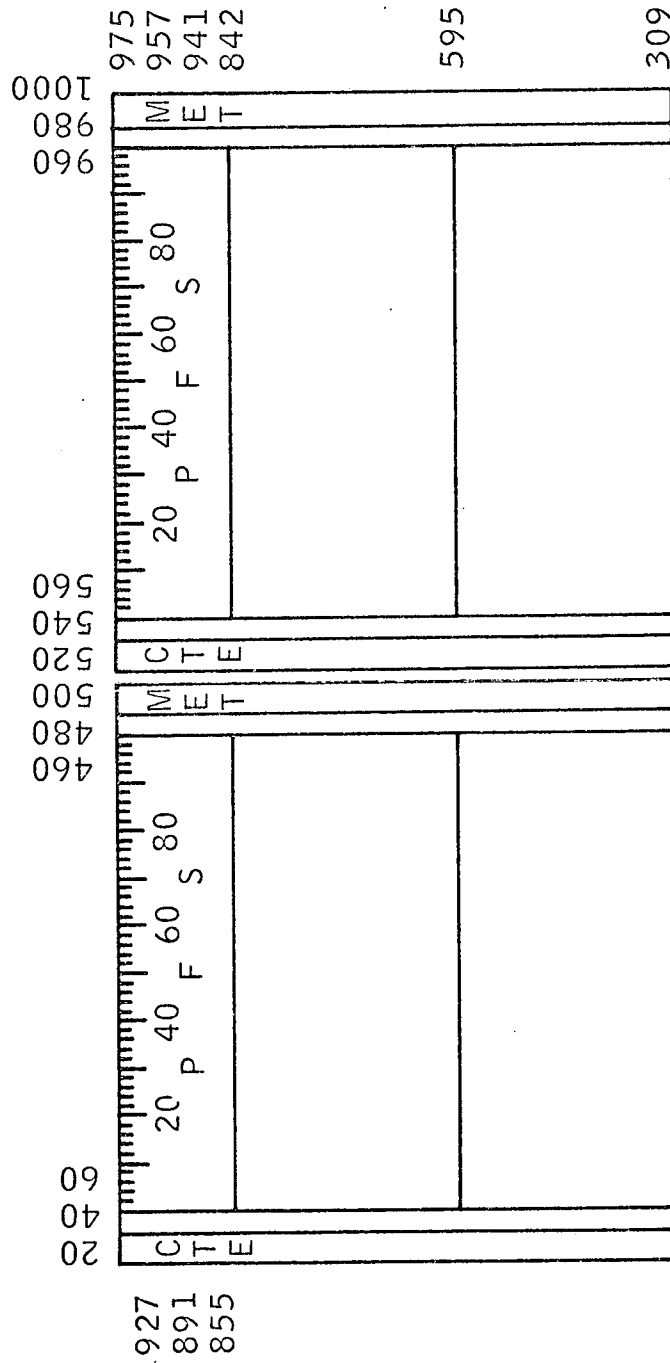
6.6.2 LBO Basic Format

The LBO basic format contains the data common to all LBO overlays. Data is entered for two overlays on each DRAFT display. Figure 6-2 illustrates the LBO basic format as it appears on the screen. The character size and dimensions on the display monitor take into consideration the final output required and the Gerber plotter scaling factors which are required. The typed dimension figures have been added to show 1024 X 1024 DRAFT coordinate positions for the common data. The CTE and MET labels refer to time recording traces along each side of the chart recording. Adjustment to each time recording will be bilevel parameter traces which differ with each subformat and LBO overlay. Both analog parameters are plotted in the same area against the 0 to 100 PFS scale at the top of the overlay.

6.6.3 Data Entry

The data presented on the four LBO's is contained in the subformats of high-speed data format 30. Selection of subformats is made according to the flight control overlay requirements. Using the requirements list, the alphanumerics of each overlay are extracted from the Flight Control data pack. Scale data is extracted from the *Operational Calibration Curve Document* and converted to the proper 1024 coordinates for entry on each overlay of the DRAFT basic format.

Analog parameters are placed on the overlay from top to bottom in the order listed in the *Flight Control Data Requirements Document*, except when the channel designators are reversed.



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Figure 6-2 LBO Basic Format

6.7 GERBER SCALE FACTORS

The DRAFT output to the Gerber produces a tape whose machine instructions are scaled to produce a D/TV mylar matte. The LBO overlays, therefore, must be scaled at the Gerber control panel to produce the appropriate overlay size. The following scale factors are entered from the control panel:

- X-Scale = 1.25
- Y-Scale = 1.00

An aperture of 5 is also selected from the control panel.

6.8 OVERLAY MASTER COMPLETION

After processing of the Gerber film positive, a header label is "waxed" onto the top of each LBO overlay. Vehicle identifiers, mission, high-speed data format, and data subformat numbers are added to the header label with image transfer characters. The overlay (Figure 6-3) is then referred to as the LBO master and is retained as the permanent record. A final QA inspection is made at this point.

6.9 POSITIVE AND NEGATIVE COPIES

A positive and negative copy of each LBO master is produced. The negative is forwarded for production of pressure sensitive copies. The positive is trimmed to required size and delivered as the completed LBO overlay.

6.10 PRESSURE SENSITIVE COPIES

The LBO overlay negative is forwarded to reproduction for printing at 1:1 size of the pressure sensitive copies. Pressure sensitive copies are delivered on receipt.

MISSION <u>A14</u> START _____ SPEED _____	
EVENT _____ FINISH _____ BY _____	
LM HS FMT 30 SFMT 36 LIVE DSE TPB	

CG	<div style="display: flex; justify-content: space-between; padding: 0 10px;"> 20 40 60 80 </div> <div style="display: flex; justify-content: space-around; padding: 0 10px;"> P F S </div>	GM
TH		HE
E		T
1		1
2	C09 GP0025 PSIA	2
3	APS HE REG P	6
0	RANGE 0 TO 300	0
	<div style="display: flex; justify-content: space-around;"> 50 100 150 200 250 </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> </div>	
	C10 GP1501 PSIA	
	APS FU PRESS	
	RANGE 0 TO 250	
	<div style="display: flex; justify-content: space-around;"> 50 100 150 200 </div> <div style="display: flex; justify-content: space-between;"> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> <div style="width: 10%; border-bottom: 1px solid black;"></div> </div>	

Figure 6-3 LBO Overlay Master

SECTION 7

MISSION OPERATION PLANNING SYSTEM DISPLAY CODING

7.1 INTRODUCTION

The mission operation planning system (MOPS) is a computer program implemented into the real-time computer complex (RTCC) which provides the facilities required for various nonreal-time applications programs.

MOPS is designed to interface with the terminal control system (TCS) and contains the real-time operating system (RTOS) and various application programs.

The overall design of each processing area (TCS, RTOS, and application programs) enables each area to provide certain general capabilities required by other processing areas; thus, general capabilities are provided by one area as a service routine. The application programs provide specific computational support relying on the facilities provided by the TCS and the RTOS.

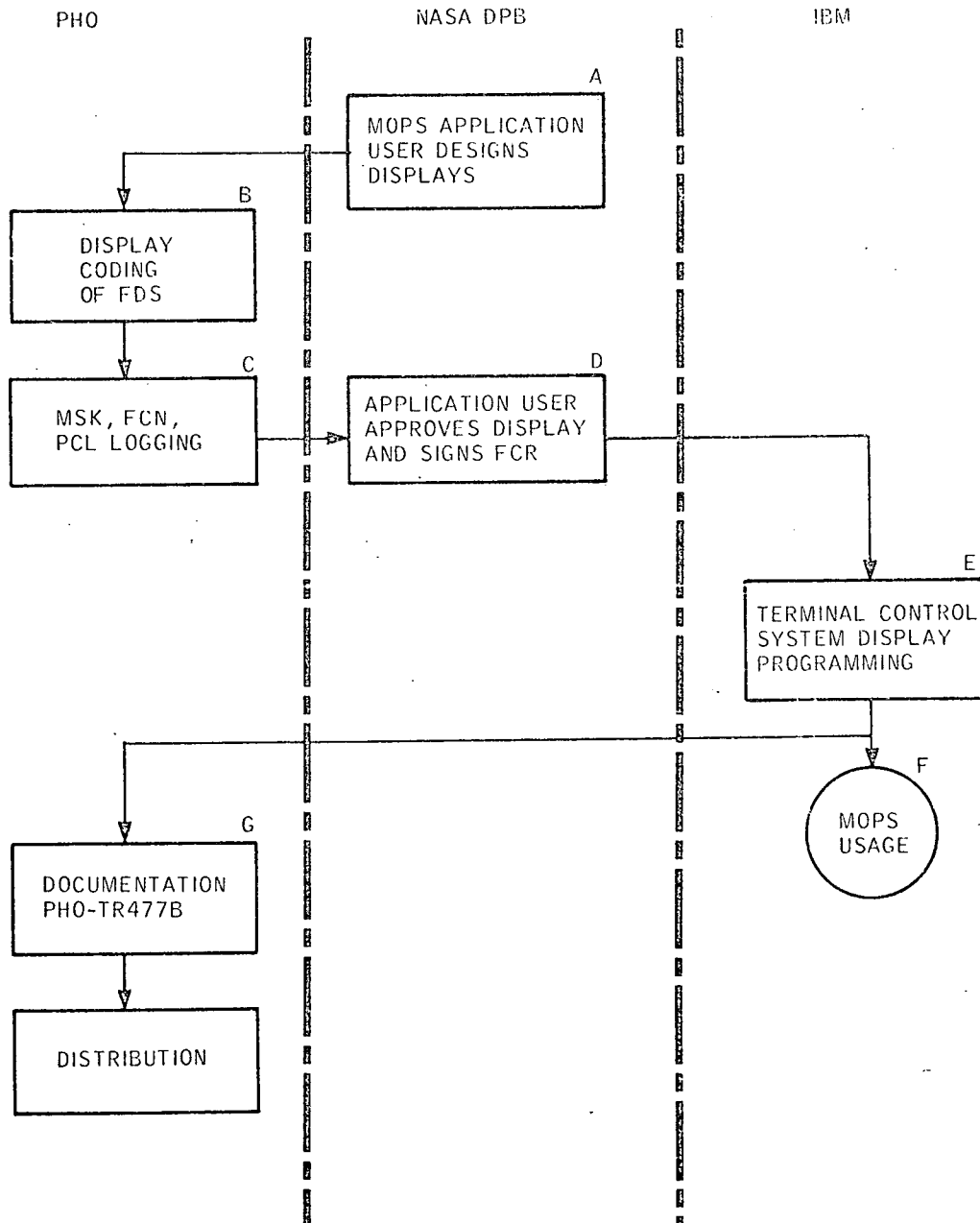
- A. TCS. The TCS is a generalized terminal control system which will provide message processing and routing in support of the terminal hardware. Functions of the TCS will be provided by the Univac 494 computing facilities. MOPS display terminals operate outboard of the Univac 494 computer.
- B. RTOS. The RTOS provides the IBM system 360/75 computer programs required by the application programs. The RTOS provides time sharing of the computer among users of the application programs.
- C. Application Programs. The application programs provide for the specific computing requirements of each nonreal-time application. Current examples of these programs are:
 - Activities scheduling program (ASP)
 - Electrical power system evaluation model (EPS)

- Control moment gyro models (CMG) (MMP)
- Computer resource operational scheduling system (CROSS)
- MCC data retrieval system (MDRS).

7.2 ORGANIZATIONAL INTERFACES

The following paragraphs and Figure 7-1 outline the organizational interfaces and functional steps during coding of displays for the MOPS terminal control system.

- A. The NASA MOPS user sketches the MOPS display on a display format worksheet and forwards the display to the PHO Display Design Section.
- B. The Display Formats engineer codes the display on 80-column format description sheets.
- C. The MSK, FCN, PCL identifiers are carefully logged to prevent unwanted duplications and provide status report data.
- D. The display DFW and FDS coding sheets are returned to DPB for checking and approval signatures on the FCR form.
- E. The approved display is forwarded to IBM for programming and inclusion in the MOPS TCS program.
- F. The completed display is used in the MOPS for monitoring and control of the application programs.
- G. After receipt by IBM, the approved display consisting of the FCR, DFW, and FDS is published in PHO-TR477B as the official documentation.



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Figure 7-1 MOPS Organizational Interfaces

7.3 DISPLAY INPUT FORMS

Data enclosed by slashes indicates terminal input data. Display input forms will be of three basic kinds: full forms, mini forms, and combination forms. The following are the characteristics of each kind of form.

A. Full Forms

- Occupies lines 4 through 48 on the terminal display
- Does not output to DTE
- Does not contain any output data
- All inputs go to the same subsystem
- The first input down from the top of the form that is filled out is executed
- Has a four-character code output by the application in the foreground that will be the first data received when the form is entered
- Has an eight-character code name that can be entered through the alphanumeric keyboard to call up the form.

B. Mini Forms. Occupies lines 49 through 53 on the terminal display. Lines 2 through 7 are the same as for the full forms.

C. Combination Forms

- Occupies lines 4 through 48 on the terminal display
- Is output to DTE
- Contains output data.

7.4 REQUIREMENTS

The requirements for MOPS displays are transmitted to IBM by five forms: display format worksheet (DFW), format description sheet (FDS), universal plot DFW, a universal plot format description sheet, and a universal timeline plot DFW. The MSK, FCN, and PCL assignment method is the same as for the current DTE system except that MSK numbers may be repeated between the ADDT, MDRS, and ASP-PEARL-MMP groupings. MSK's 0500-4300 and FCN's 4000-4999 are utilized for MOPS. See Table 7-1.

The FCN has one of the following prefixes:

- "A" for activity scheduling program
- "M" for MDRS identifier MCC data retrieval system
- "E" for program for electrical power system analysis and rapid look ahead
- "C" for momentum management processor
- "D" for all data digital tape.

The following paragraphs describe guidelines used in coding both the DFW and FDS sheets. An FCR is required for each display.

7.4.1 Display Format Worksheets

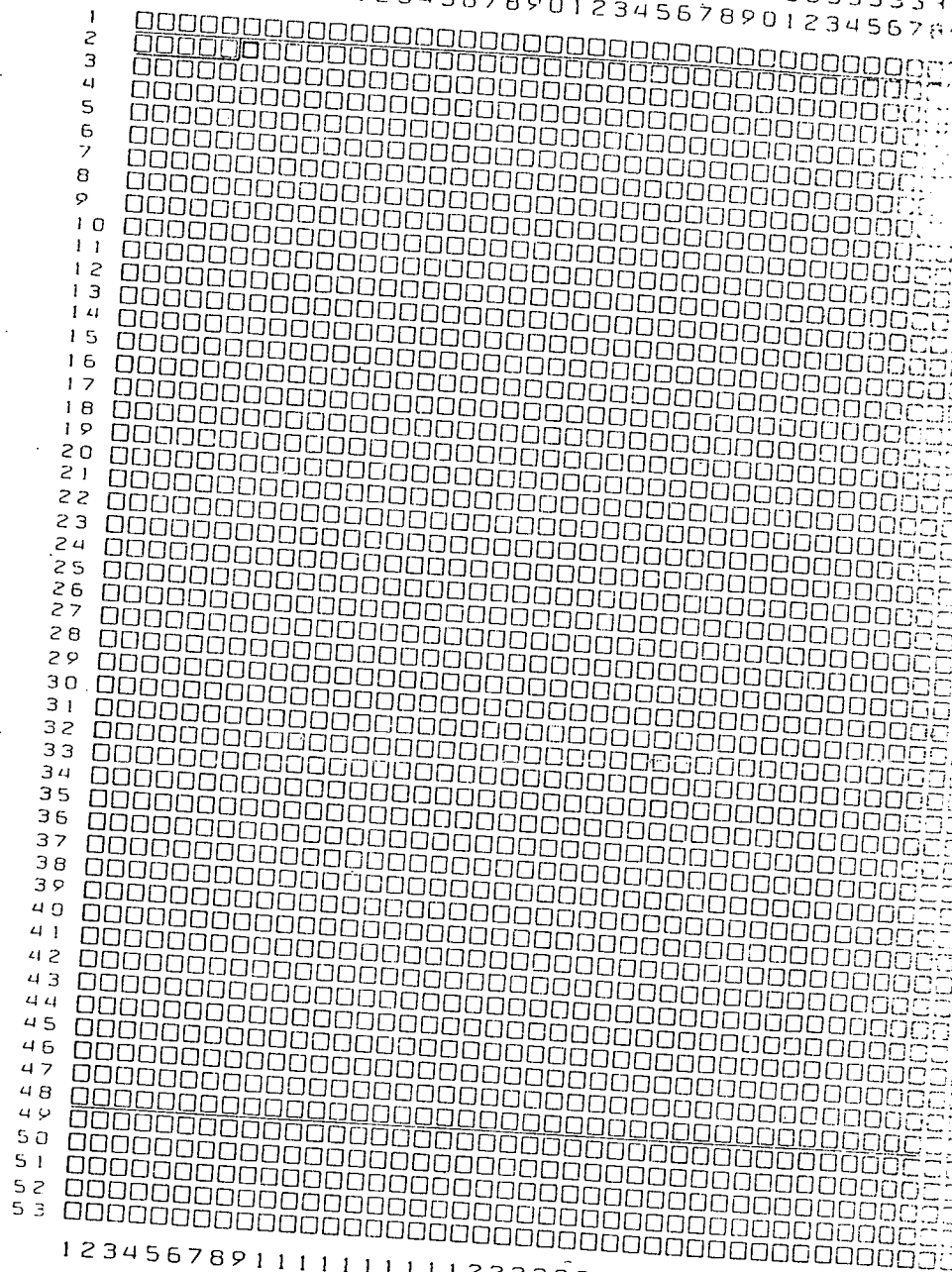
The display format worksheet contains the layout of the display for both foreground and background data. The term foreground data is used interchangeably with dynamic data. There are two row and column display format worksheets, one a 53 X 74 and the other a 53 X 64. The 53 X 74 is for a mode A display (see Figure 7-2); the 53 X 64 is for a mode B display (see Figure 7-3). The existing mission DFW's are used for dependent mode. Data on the mode A and mode B worksheet is defined by row and column. Positioning of characters between character boxes is not allowed. Vectors (lines) must originate in the center of a character box and end in the center of a character box. Reference Figure 7-4.

TABLE 7-1
MOPS CHARACTER SET

SP	0	Y	P	ψ	p
!	1	A	Q	a	q
~	2	B	R	b	r
#	3	C	S	c	s
\$	4	D	T	d	t
%	5	E	U	e	u
&	6	F	V	f	v
'	7	G	W	g	w
(8	H	X	h	x
)	9	I	Y	i	y
*	:	J	Z	j	z
+	;	K	Σ	k	c
,	<	L	θ	l	
-	=	M	—	m	—
.	>	N	π	n	λ
/	?	O	ϕ	o	Δ

FOLDOUT FRAME 2

12345678911111111122222222223333333333
012345678901234567890123456789



12345678911111111122222222223333333333444
012345678901234567890123456789012

FOLDOUT FRAME 2

MOPS TITLE		PREP BY		APPR BY		PAGE		OF	
10		40		50		70		80	
1	EXTERNAL NAME	28	31	UNIT	536	1	39	40	0
2	FORMAT	28	31	UNIT	536	1	39	40	0
3	TYPE/	28	31	UNIT	536	1	39	40	0
4	BLEVEL	28	31	UNIT	536	1	39	40	0
5	COORD	28	31	UNIT	536	1	39	40	0
6	LABEL	28	31	UNIT	536	1	39	40	0
7	COMMENTS	28	31	UNIT	536	1	39	40	0

Figure 7-4 MOPS Tabular FDS

The location of the FCN, PCL, and MSK is standard on the mode A and mode B worksheets. The location of the FCN is row 2, columns 1,2,3,4,5. The PCL is located at row 2, column 6. The location of the MSK is row 2, columns 71-74. The title of the displays is also located on row 2. The rows are numbered from top to bottom. The columns are numbered from left to right. Tick marks are placed on the left-hand side of the worksheet to denote segments.

7.4.2 Standard Display Format Worksheets

There are two standard DFW's: a universal timeline/event plot and a universal plot. The programming requirements for the universal plot are defined in PHO-TR477. The coordinates for the universal plot are 14,40; 74,40; 74,8; and 14,8. The coordinates for the timeline/event plot are 21,40; 73,40; 73,4; and 21,4.

7.4.3 Format Description Sheets

There are two format description sheets: one for the tabular displays and one for the universal plot display. These sheets contain information that is needed for coding of both the foreground data and background data for the display. The information needed to program the foreground quantities is the right-most character of the foreground data. Both background data and foreground "X" symbols are coded within the FDS format field.

7.5 WORKSHEET DESCRIPTION

7.5.1 Format Description Sheets

7.5.1.1 MOPS Tabular Display Format Description Sheet

A. Header Information

1. Card No. 1

- a. CC1-4. Four bytes for type of display.
 - MMA = Mode A
 - MMB = Mode B
 - MMDT = Dependent (terminal)
 - MMDD = Dependent (DTE).
- b. CC5. One byte for application. A = ASPS, M = MDRS, D = ADDT, E = PEARL, C = MMP.
- c. CC7-10. Four bytes for the FMT number this display.
- d. CC11. One byte for PCL.
- e. CC14-18. Four bytes for the FCN and one byte for prefix. The prefixes are as follows:
 - A = ASP
 - M = MDRS
 - D = ADDT
 - E = PEARL
 - C = MMP.

CC20 is as follows:

- ⊙ MOPS A = 1
- ⊙ MOPS B = 2
- ⊙ PLOT = 1.

2. Card No. 2. CC13-79 has 66 bytes for display title (as shown on DFW).

B. Parameter Information

1. Parameter Cards

- a. CC2-13. Twelve bytes for the external name. The external name field consists of the telemetry (TLM) measurement number or, in the case of special parameters, the identifying number provided by NASA Data Processing Branch (DPB).

- (1) Segment Card. The first four columns in the external field will designate the segment that is being described. Column 1 will be S, columns 2 through 4 will be 000 for zero segment and 001 for segment one, etc. There will always be at least two segments except on input form displays which have only segment one. Where the DFW does not show where the different segments divide, then segment zero will be the first line FCN, TITLE, and MSK. Segment one is the rest of the display.

SEGMENT CODING

Col 1 2-4

S 001 S = Segment 001 = Segment 1

- (2) Repeat Card (Universal Tab). The data in column that repeats itself requires a repeat card if all data is alike. Column 1 shall have an R; column 2 and 3 shall designate the amount of times a column repeats.

REPEAT CODING

Col 1 2-3

R 25 R = Repeat 25 = Column repeats
25 times

- (3) Segment Zero. Segment zero is header information (rows 2 through 7). It is defined one time (even when more than one page is present).
- (4) Segment One. Segment one, etc., is body information.
- (5) Line Address for Segments. X,Y address for start of each segment.
- (6) Vector Coding (CC2-12). The first twelve columns in the external field will show the vector start and end points within a segment. Column 1 shall have a V designator. The starting X and Y shall be in columns 2-3 for X and 5-6 for Y. The ending X and Y shall be in columns 8-9 for X and 11-12 for Y. All vectors will start and stop in center of character box.

VECTOR CODING

	<u>STARTING</u>		<u>STOPPING</u>	
	X1	Y1	X2	Y2
Col 1	2,3	5,6	8,9	11,12
V	V = Vector			

- b. CC14-29. Sixteen bytes for the format field which can contain from 1 to 16 characters and is used to describe the configuration of the background and dynamic data to be displayed.

- (1) Overflow in Format Field of FDS. Background data that overflows the format field shall be put on a second time with a new X,Y address where the second line starts.

Dynamic data that overflows the format field shall be put on one line with a number of dynamic symbols with X behind them such as 30X for 30 dynamic symbols. All data in the format field shall be left adjusted starting at column 14.

- (2) A \pm symbol on the DFW will be entered on the FDS as a minus.

- c. CC44-51. The coordinate field consists of two four-character fields. The first field is the X or column field, and the second is the Y or row field. The numbers placed into the row field will be the row number of the quantity to be displayed. In the cases where the quantity to be displayed is a time that must be split up between two lines, the row number of the top row should be input.

The numbers put into both the row and column fields may be either left or right adjusted. The program which reads the input cards will right adjust the input numbers before processing. The column field will contain the column number of the first (left most) character of the field to be displayed (excluding the error column if present). The first character is used to ease the job of inserting column numbers on displays that have columns of data.

If segments on the DFW have blank lines (rows) between them, enter the X,Y coordinates for the blank lines (rows) in the coordinate field of the FDS. The X coordinate will always be 01.

- d. CC53-79. Twenty-eight bytes for the label comments field which may be used for pertinent information as required for FCD, FSB, etc. Dynamic data labels only should be entered in this field. Use 80 PCL letter for changes.

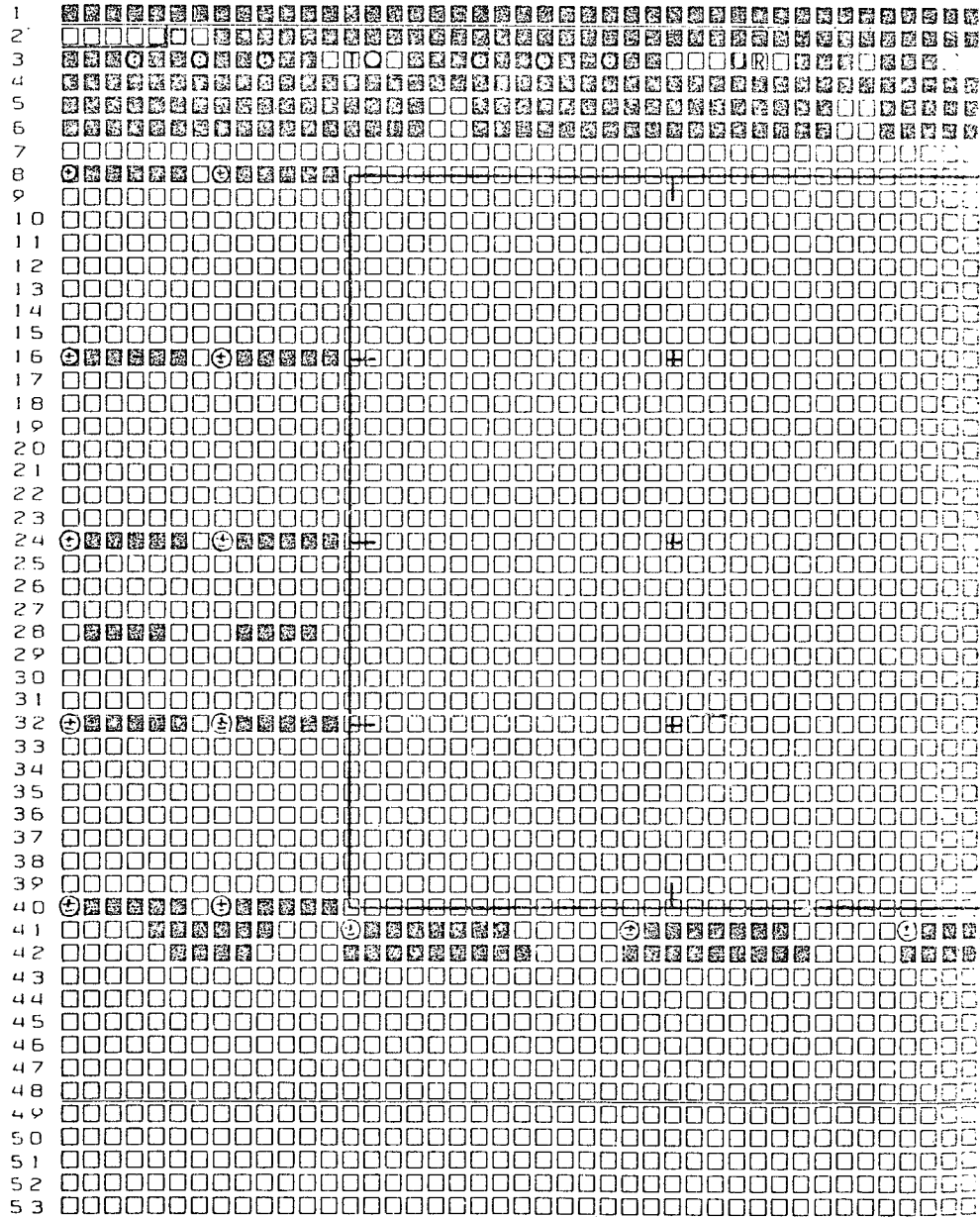
7.5.1.2 MOPS Universal Plot Displays

Universal plots will plot a maximum of four Y parameters against one X parameter, using a maximum of two Y scales and one X scale. Any MDRS parameter having a decimal or time equivalent may be plotted, and an event (i.e., day/night) may also be indicated in the plot area. See Figure 7-5.

7.5.2 Display Format Worksheet

- A. Line 2. A plot title of up to 61 characters in length.
- B. Line 3
 - 1. Times. The start and stop times of the report (DDD:HH:MM:SS).
 - 2. UR. The plot update rate and units (HR, MIN, SEC, SPS).
 - 3. XS. The RTCC and English names of the X parameter.
- C. Line 4. Remote-text (EV:) in columns 46-48 and the RTCC and English names of a special computation event indicator.
- D. Line 5. A 12-character English name and a scale factor (X), if applicable, for Y parameters 1-4, left to right.
- E. Line 6. A 12-character RTCC name, scale label, and scale assignment, =1(L), if applicable, for Y parameters 1-4.

123456789111111111122222222223333333333344444
0123456789012345678901234567890123



123456789111111111122222222223333333333344444
0123456789012345678901234567890123

[illegible]

7-17

- F. Line 8. Upper bounds of Y scales.
- G. Lines 8,16,24,32,40. Five equal interval values for each Y scale (L,R). The format is $\pm XXXXX$ with a floating decimal point. If the scale values will not fit in this format, use scientific notation (X.XXX) with exponents on line 28.
- H. Line 28. Scientific notation exponents for each Y scale ($E\pm XX$).
- I. Line 40. Lower bounds of Y scale.
- J. Line 41
 - 1. X Exponent. Remote-test (XbEXP:) if scientific notation is required for the X scale values.
 - 2. X Scales. Five equal interval values for the X scale. For EU X plots, the format is $\pm XXXXXXX$. For time X plots, the format $\pm DDD:HH:$ shall be used.
- K. Line 42
 - 1. X Exponent. The exponent value ($E\pm XX$) if scientific notation is required for EU X scale values on line 41.
 - 2. X Time. For time X plots, the continuation of the time values on line 41 (MM:SS.SSS).
- L. Columns 14,74. The left and right bounds of the X scale.
- M. Lines 2-7. Considered header information.
- N. Point Plotting/Vector or Line Plotting. Two types of plotting will be required: point plotting and vector or line plotting. At least 250 points per parameter per page may be output.
- O. Foreground/Background Plotted Data. Plotted data will be of two types: foreground and background. Foreground may be either vector or point plotting. The same applies to background.

- P. Traces. Different traces will be distinguished by placing a number corresponding to the Y parameter (1,2,3,4) at points along the trace. The numbers will be staggered such that they will not appear in the same display columns. The number of points between numbers will be specified with each format. The numbers will not, if possible, overlay data.
- Q. Faulty Data. (H,L,M,X,P, etc) will not be plotted when there is a gap in the data.
- R. Special Computation Events. The capability will exist to plot special computation events. When so indicated by the computation, a tick mark will be output in the correct position on the X time scale on line 14. The tick may be preceded or followed by short remote-text (DAY/NT).
- S. Scale Factor. If a scale factor is present, the parameter will be multiplied by the scale factor, and the result will be plotted. The default scale factor of one will not be output.

7.5.3 Format Description Sheet

Figure 7-6 illustrates the MOPS universal plot format description sheet. Title line entries (FCN, PCL, title, and MSK) on DFW will be the only non-standard information concerning MOPS universal plots, and these are the only entries required on the FDS. Standard information on the DFW's do not require FDS entry and will not be shown on the FDS. IBM will accomplish the task of extracting FDS information for standard DFW information.

A. FDS Header Information

1. Card No. 1

- a. CC1-4. Type MPLT (M=MOPS, PLT=PLOT).
- b. CC5. Application (A=ASPS, M=MDRS, D=ADDT, E=PEARL, C=MMP).
- c. CC7-10. Format number (FMT).

TITLE _____								PREP. BY _____		PAGE ____ OF ____	
		FMT C L	P C	FCN		UR	U _N ITS	EVENT INDICATOR	FMT		
1	2	3	4	5	6	7	10	18	14	18	
IMPLT											
TITLE											
EXTERNAL NAME		LABEL		SCALE FACTOR		COMMENTS					
8	1516	2728	3738								
1	2	3	4	X							
Y1											
Y2											
Y3											
Y4											
EU MIN		EU MAX		COMMENTS							
1	2	3	1516	2728	76						
X											
YR											
YL											

Figure 7-6 MOPS Universal Plot FDS

- d. CC11. Program change letter (PCL).
- e. CC14-18. Format control number (FCN) 4 digits and 1 digit for prefix.
- f. CC39-41. Update rate (UR).
- g. CC43-45. Nomenclature describing the update rate (units).
- h. CC54-65. Event indicator for special events, i.e., day, night, noon, etc.
- i. CC77-80. Format numbers (FMT).

2. Card Number 2. CC7-67 is the plot title.

B. Parameter Cards

1. Line 1

- a. CC1. (X) for X axis parameter.
- b. CC2. (T) for time plot (otherwise blank).
- c. CC3. Blank for X axis parameter.
- d. CC4-15. RTCC external name of X axis parameter.
- e. CC16-27. Label or description of X axis parameter.
- f. CC28-37. Blank for X axis parameter.
- g. CC38-79. Comments field.
- h. CC80. PCL.

2. Line 2

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (1) for Y1 axis parameter.

- c. CC3. (L) or (R) for plotting the left or right grid of Y1 axis parameter.
- d. CC4-15. RTCC external name of Y1 axis parameter.
- e. CC16-27. Label or description of Y1 axis parameter.
- f. CC28-37. Scale multiplying factor for Y1 axis parameter if blank multiplying factor equals one.
- g. CC38-76. Comments field for Y1 axis parameter.
- h. CC77-80. Format number.

3. Line 3

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (2) for Y2 axis parameter.
- c. CC3. (L) or (R) for plotting the left or right grid of Y2 axis parameter.
- d. CC4-15. RTCC external name of Y2 axis parameter.
- e. CC16-27. Label or description of Y2 axis parameter.
- f. CC28-37. Scale multiplying factor for Y2 axis parameter if blank multiplying factor equals one.
- g. CC38-76. Comments field for Y2 axis parameter.
- h. CC77-80. Format number.

4. Line 4

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (3) for Y3 axis parameter.

- c. CC3. (L) or (R) for plotting left or right grid of Y3 axis parameter.
- d. CC4-15. RTCC external name of Y3 axis parameter.
- e. CC16-27. Label or description of Y3 axis parameter.
- f. CC28-37. Scale multiplying factor for Y3 axis parameter if blank multiplying factor equals one.
- g. CC38-76. Comments field for Y3 axis parameter.
- h. CC77-80. Format number.

5. Line 5

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (4) for Y4 axis parameter.
- c. CC3. (L) or (R) for plotting left or right grid of Y4 axis parameter.
- d. CC4-15. RTCC external name of Y4 axis parameter.
- e. CC16-27. Label or description of Y4 axis parameter.
- f. CC28-37. Scale multiplying factor for Y4 axis parameter if blank multiplying factor equals one.
- g. CC38-76. Comments field for Y4 axis parameter.
- h. CC77-80. Format number.

C. EUMIN and EUMAX

1. Line 1

- a. CC1. (X) for X axis parameter.
- b. CC2. Blank.

- c. CC3-15. Engineering units minimum for X axis parameter; blank if X is time.
- d. CC16-27. Engineering units maximum for X axis parameter; blank if X is time.
- e. CC28-76. Comments field for X axis parameter.
- f. CC77-80. Format number.

2. Line 2

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (R) for right grid of Y axis parameter.
- c. CC3-15. Engineering units minimum for YR axis parameter.
- d. CC16-27. Engineering units maximum for YR axis parameter.
- e. CC28-76. Comments field for YR axis parameter.
- f. CC77-80. Format number.

3. Line 3

- a. CC1. (Y) for Y axis parameter.
- b. CC2. (L) for left grid of Y axis parameter.
- c. CC3-15. Engineering units minimum for YL axis parameter.
- d. CC16-27. Engineering units maximum for YL axis parameter.
- e. CC28-76. Comments field for YL axis parameter.
- f. CC77-80. Format number.

7.5.4 Universal Timeline Plot DFW

Universal timeline plots will plot a maximum of nine event Y parameters against one X time parameter. See Figure 7-7.

- A. Line 2. A plot title of up to 61 characters in length.
- B. Line 3
 - 1. Times. The start and end times of the report (DDD:HH:MM:SS).
 - 2. UR. The plot update rate and units.
- C. Lines 5,9,13,17,21,25,29,33,37. English names of the event parameters 1-9, respectively.
- D. Lines 6,10,14,18,22,26,30,34,38. RTCC names of the event parameters 1-9, respectively.
- E. Lines 7,11,15,19,23,27,31,35,39. Status information of the event parameters 1-9, respectively.
- F. Line 41. The X time parameter English name and five equal interval X scale time values (\pm DDD:HH:).).
- G. Line 42. The X time parameter RTCC name and the continuation of the line 41 time values (MM:SS.SSS).
- H. Lines 2 and 3. Considered header information.
- I. Vector Plotting. Required for the universal timeline plot.
- J. Plotted Lines. Each parameter will have two states corresponding to upper and lower plotted lines (see DFW for location of lines). The upper line will be plotted when the parameter is in the state described in the status line for that parameter. The status information will be of the form UPPERb=bX where X is a binary 1 or 0; X may also describe a remote-text condition by use of apostrophes ('ON,' 'OPEN,' etc.). The lower line will be plotted when the parameter is not in the state described in the status line and is not missing.
- K. Missing Data. Indicated by gaps in the line.

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FOLDOUT FRAME 1

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COMMENTS		MSK	FCN		FCR NO.	DATE	DRK SELECT BUTTON TITLE	F/C POS	TYPE	PAGE	OF
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	IBM										
	IBM										
	FCD										
	FCD										
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	RTPDB										

Figure 7-7 MOPS Mode A (53 X 74)
 Universal Timeline Plot

SECTION 8

MODULE OVERLAYS

8.1 INTRODUCTION

Module overlays provide for rapid reconfiguration of labels for console modules. The overlays are assembled from several layers of film incorporating window masks, label alphanumerics, and color filters.

The Requirements and Configuration Section of Philco identifies the requirements for module overlays for each mission, issues working lists, and documents the requirements in PHO-TR155.

Non-variable module overlays are identified only by console, module, and mission. Variable event module overlays may be changed in near real-time. These are identified by MSK format call-up numbers corresponding to computer program resident event lists. A sequentially increasing format control number (FCN) is assigned to each 36- and 72-variable event artwork. The ranges are 5000-5999 for 36 events and 6000-6999 for 72 events.

Copies of preliminary PHO-TR155 working lists give the window label position, color (or white), label alphanumerics, and the quantity required.

The following paragraphs and Figure 8-1 outline the steps in the overlay production process.

8.2 WINDOW MASK MASTER

A window mask master is constructed to the dimensions required for each type of module. The master is then used to print the required number of standard window masks.

- A. 36-Event Window Mask. Figure 8-2 gives the dimensions required for the 36-event overlay window mask. The small window at the lower right provides for the FCN and the MSK call-up number.

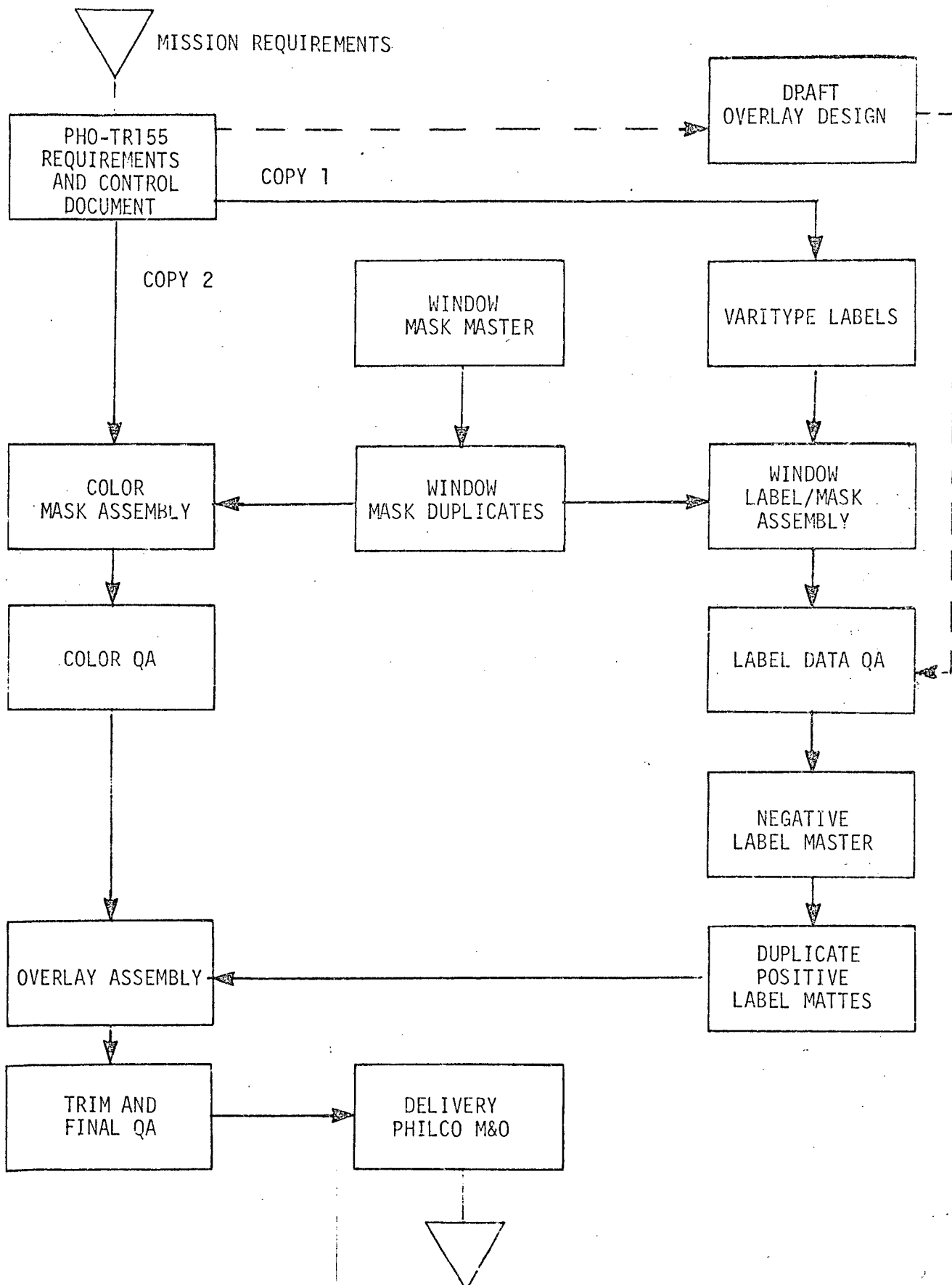
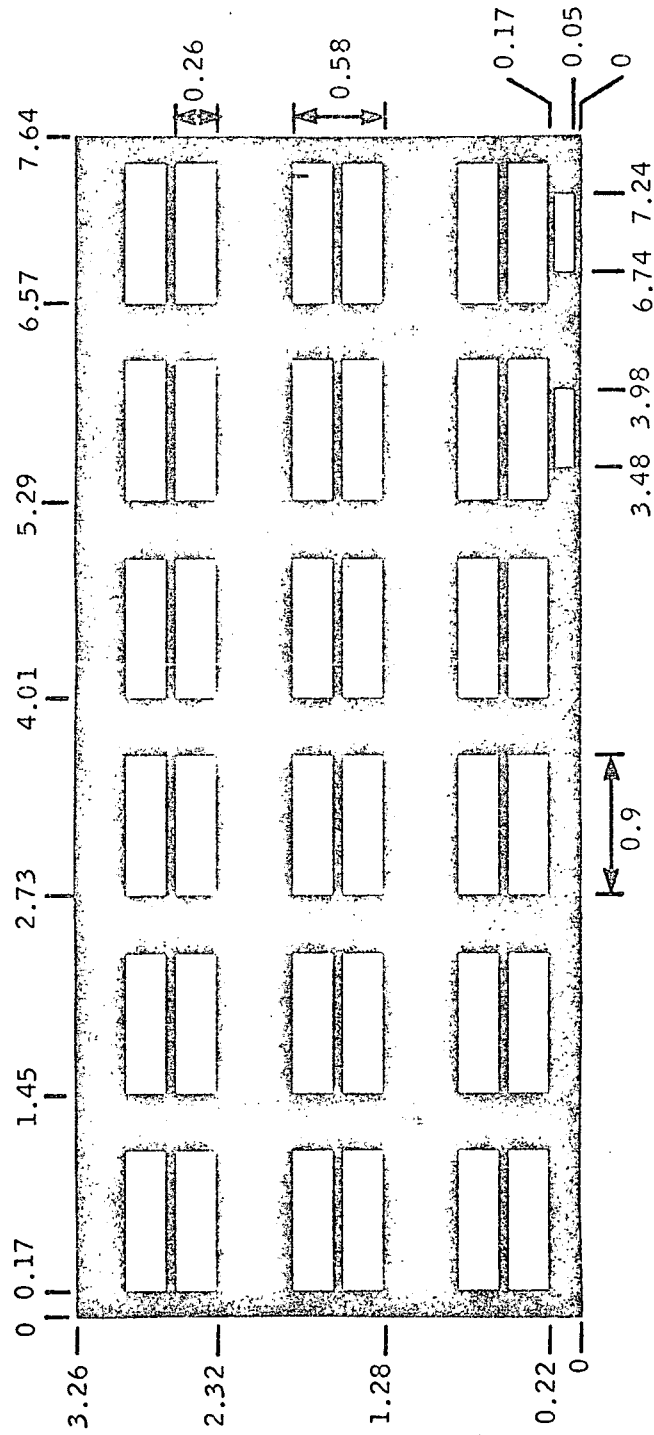


Figure 8-1 Panel Overlay Production Flow



AA10-08(A) 3

Figure 8-2 36-Event Module Window Mask

- B. 72-Event Window Mask. Figure 8-3 gives the dimensions for the 72-event overlay window mask. The right hand label window is used for the MSK call-up number. The small horizontal window between label windows is used for the FCN.
- C. Raytheon Module Window Mask. Figure 8-4 gives the dimensions for the Raytheon module overlay window mask. Small inter-label windows provide for console, module, and mission ID.

8.3 WINDOW MASK DUPLICATES

Two standard window masks are required for the first overlay. Each additional overlay requires a rear window mask for color application. Duplicates are produced from the window mask master in the quantity needed for all overlays. Both front and back masks for the 36 window modules are printed on clear film. The 72-event rear window masks used for color application are printed on matte finish film to provide added light diffusion. The 72-event front window mask used for the positive type assembly is clear film.

8.4 VARITYPE LABELS

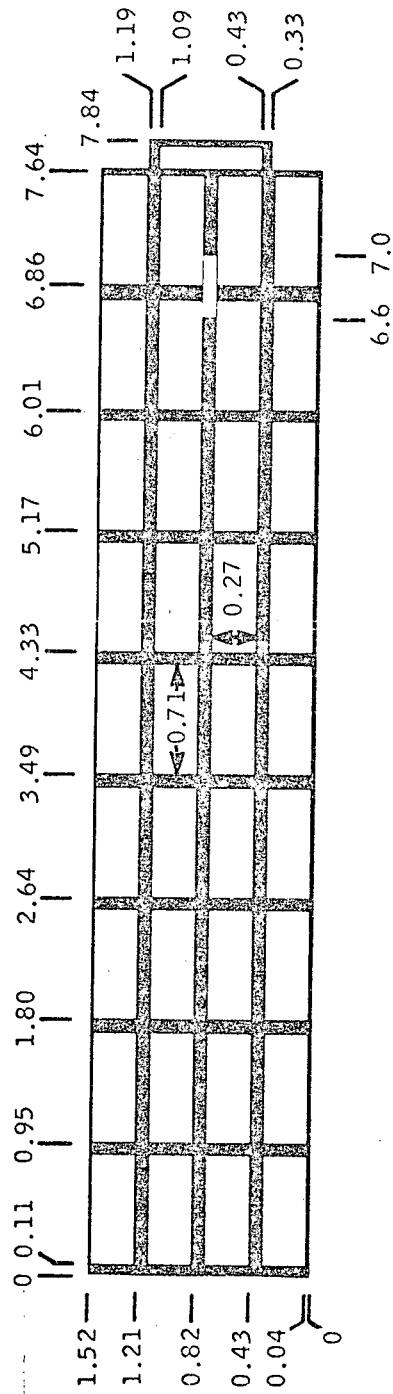
Using the Varitype Headliner 810, No. 3315 film is exposed character-by-character to produce the alphanumerics for each label. Seven-point type is used for 72-event overlays and eight-point type is used for 36-event and Raytheon module overlays. The type is a block style gothic font. Exposure and processing produce dense black characters on clear film (positive image).

8.5 WINDOW LABEL ASSEMBLY

The positive labels produced on the varityper are positioned and taped to a standard window mask within the proper window by following the PHO-TR155 listing.

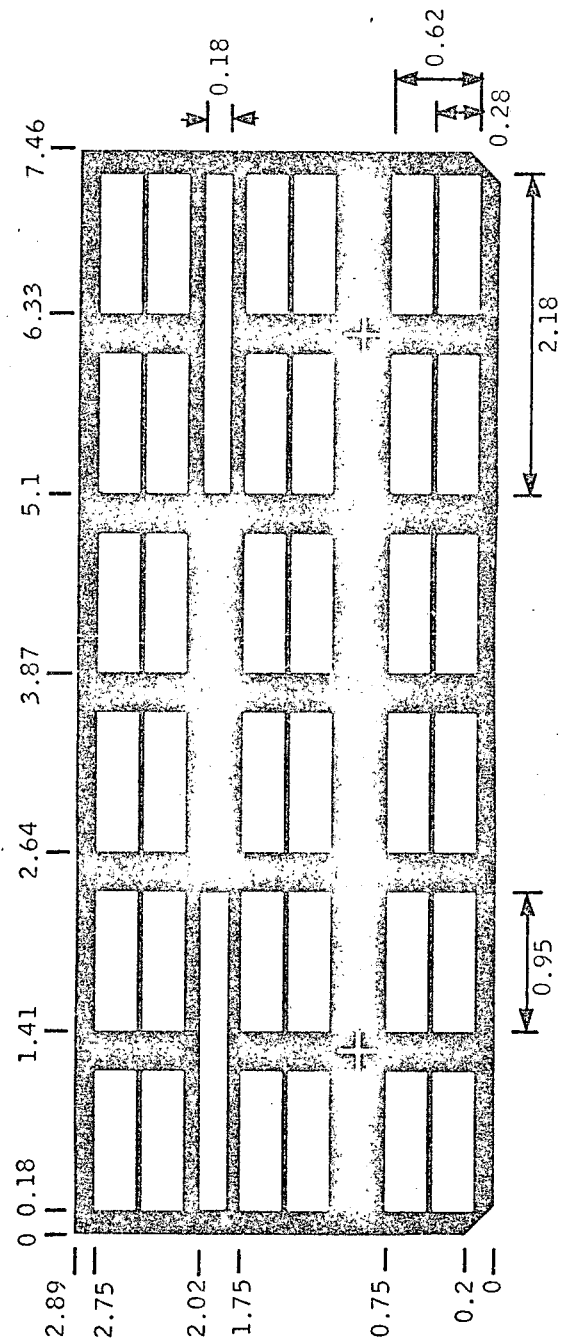
8.6 DRAFT OVERLAY DESIGN

The display retrieval and formatting technique (DRAFT) may be used to support production of positive labels. This effort parallels the production of labels on the varityper and their assembly into a label mask. Using PHO-TR155 listings as a guide, an operator



AA10:08(A) 2

Figure 8-3 72-Event Window Mask



AA10-08(A)-1

Figure 8-4 Raytheon Module Window Mask

types in label data at standard 1024 × 1024 coordinates to create a display with all 36 labels. After entry in the DRAFT data base, a Gerber tape is generated and taken for plotting to the Gerber automatic drafting machine in Bldg. 17. Appropriate scale factors entered at the Gerber control panel permit stretching and compressing the display image so that labels will exactly match the window mask areas of each type of module. The Gerber film is developed, and the positive is trimmed to overlay size prior to label data QA.

8.7 LABEL DATA QA

After assembly of the film labels to a window mask, a careful inspection is made for quality and correspondence of label data with the label requirements shown on the PHO-TR155 listing.

8.8 NEGATIVE LABEL MASTER

After QA of the positive assembly of window mask and label alphanumerics, the negative label master is printed and processed.

8.9 POSITIVE LABEL MATTES

Using the negative label master, the required number of label mattes is printed on a matte finish film to produce a positive image window label.

8.10 COLOR MASKS

Parallel to window label production, the color window masks are produced. Each final overlay assembly requires a separate color window mask. Two layers of colored tape are applied over each window as required by the PHO-TR155 listing. Colors used are amber, green, blue, and red.

8.11 COLOR QA

Each color mask assembly is carefully checked against the listing for correct application of color to each window.

8.12 OVERLAY ASSEMBLY

Final assembly of the overlay is accomplished by applying double stick tape to the opaque areas of the color mask. The front label mask is then carefully registered on the color mask and pressure applied to seal the tape.

Seventy-two event overlays require an additional matte film diffuser which is applied over the color mask before pressing on the front window label.

8.13 TRIM AND FINAL QA

Excess film is carefully trimmed away from the outer edges of the overlay. A final inspection of the overlay assembly is then made for size, label, and color accuracy.

8.14 DELIVERY

Delivery is made to Philco M&O.

SECTION 9

MOPS KEYBOARD OVERLAY PRODUCTION

9.1 INTRODUCTION

The MOPS keyboard overlays identify program functions initiated by the individual keys on the MOPS keyboard. Labels are printed on white Dupont Cronopaque film in eight-point type above each key position. Two sets of labels above each key are identified with the shift or shift clear position of the shift keys. See Figure 9-1.

Larger 12-point type indicates which line of labels are shifted functions and also identifies along the right side the overlay name and version number.

Requirements are received from the Systems Engineering Branch of NASA's Flight Support Division in the form of new or updated requirements.

9.2 VARITYPE LABELS

Labels for each keyboard function key are produced on the Varitype Headliner Model 8101 using No. 3315 positive film. Type font is eight-point block Gothic. After development, the label typesheets are waxed on the back and labels separated for mounting on clear film.

9.3 PASTE-UP

A clear sheet of film is pin registered over a standard paste-up guide. The individual labels are pressed into position line-by-line or word-by-word. The paste-up guide is viewed through the clear film permitting centering and accurate alignment to future label window positions. Care is exercised to match the wax mounted characters with the requirements input sketch.

9.4 LABEL NEGATIVE

A keyboard label negative is printed from the positive label paste-up.

Key Production File

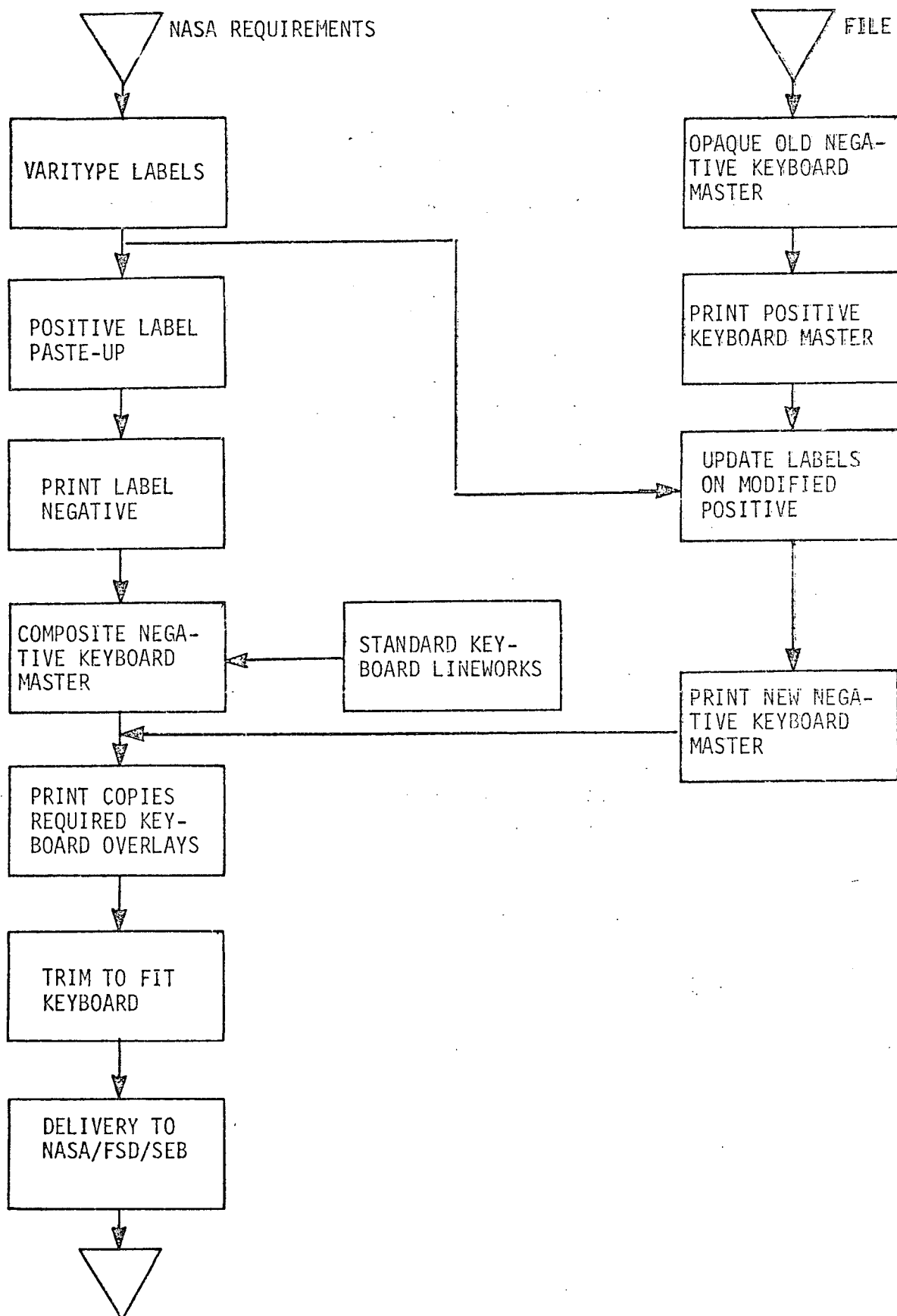


Figure 9-1 MOPS Keyboard Overlay Production Flow

9.5 STANDARD LINEWORK

A standard set of lineworks comprises the reference for separating key labels and trim areas. Figure 9-2 gives the dimensions used for the standard lineworks. Horizontal and vertical lines dividing the labels are cut on scribecoat with the coordinatograph. Trim areas and dimension cut lines are scribed with lighter weight lines on a second sheet.

9.6 LABEL AND LINEWORK COMPOSITING

Using a pin-registration system, the label negative and standard lineworks are sequentially printed on mylar film. This creates a negative composite image when developed which is called the negative keyboard master.

9.7 OPAQUE OLD NEGATIVE KEYBOARD MASTER

Updating of a negative keyboard master begins with varityping the new labels. Parallel to new label production, the existing negative keyboard master is pulled from the tub files and opaque tape is placed over the key labels to be updated.

9.8 POSITIVE KEYBOARD MASTER

The opaque taped negative keyboard master is printed and developed to produce the positive keyboard master.

9.9 UPDATE LABELS

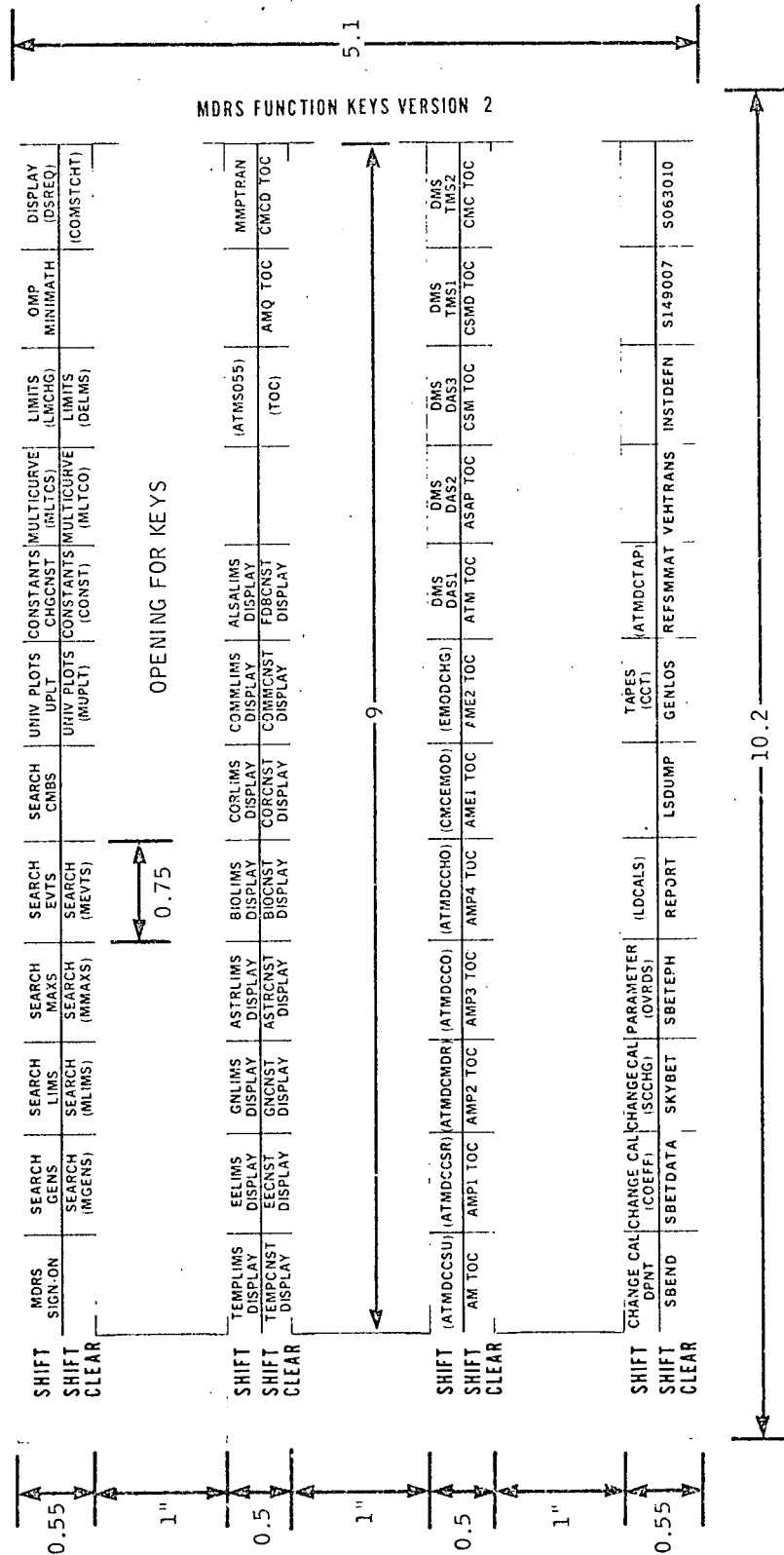
The new labels produced on the varityper are pressed on in the clear key areas of the positive keyboard master according to the update requirements sketch.

9.10 NEW NEGATIVE KEYBOARD MASTER

A single exposure of the positive keyboard master produces the new negative keyboard master.

9.11 PRINT KEYBOARD OVERLAY COPIES

The desired number of copies of the MOPS keyboard overlay is printed from original or new negative keyboard masters on white Dupont Cron-opaque film.



AA100B B

Figure 9-2 MOPS Keyboard Overlay Dimensions

9.12 TRIM TO FIT

Each Cronopaque film sheet is trimmed to fit the MOPS keyboard. Figure 9-2 shows overall dimensions and the area which must be removed for key operation. Trimming is accomplished manually with metal straight-edge and linoleum knife.

9.13 DELIVERY

Delivery of MOPS keyboard overlays is made to the Systems Engineering Branch of NASA's Flight Support Division.

APPENDIX A

DRAFT SYSTEM CHARACTER SET

A.1 GENERAL

Table A-1 lists the codes for the DRAFT and DTE symbol library. Columns are defined as follows.

- A. DTE Octal. This is the DTE 8-bit octal code.
- B. DRAFT Key. This is the key position on the DRAFT keyboard. U or L indicate the shift position if applicable.
- C. HEX Code. This number correlates the RTCC print chain codes for the HN train and PHO train with the COM.
- D. FDS List. This column indicates symbols which are substituted on the FDS printer listing. Note 1 applies to tabular displays; note 2 applies to plot displays; and note 3 applies to the plot character field on plot display.
- E. Graphic Symbol. Pictures the symbol displayed on the DRAFT DTE monitors.
- F. Symbol Name. Describes or names symbol.

TABLE A-1
DRAFT SYSTEM CHARACTER SET

DTE OCTAL	DRAFT KEY	HEX CODE	FDS LIST		GRAPHIC SYMBOL	DRAFT SYMBOL NAME
			NOTE	SYMBOL		
123	18U	01	2,1	@	α	SMALL ALPHA
065	19U	02	2,1	¢	β	SMALL BETA
140	16U	03			°	DEGREE
067	21L	04	2,1	\$	δ	SMALL DELTA
366	79U	05			Σ	CAPITAL SIGMA
345	20U	06			Γ	CAPITAL GAMMA
066	20L	07	2,1	;	γ	SMALL GAMMA
272	82U	08			Ω	CAPITAL OMEGA
160	18L	0A				SP1 (SPARE DTE)
122	19L	0B				SP2 (SPARE DTE)
114	77L	0D			[LEFT BRACKET
026	78L	0E]	RIGHT BRACKET
330	97U	0F			☐	DOTTED BOX
006	37L	10			☐	BOX
267	41L	13			λ	SMALL LAMBDA
201	61U	17			π	SMALL PI
072	80L	18			ϕ	SMALL PHI
304	59L	19			^	POINTER
045	39L	1D			-	OVERSCORE
346	40L	1E				SP5 (SPARE DTE)
220	60L	1F				SP8 (SPARE DTE)
162	62U	21			ρ	SMALL RHO
134	40U	23			Θ	CAPITAL THETA
202	59U	24			μ	SMALL MU
070	21U	25	2,1	%	Δ	CAPITAL DELTA
271	82L	26			ω	SMALL OMEGA
367	80U	27			Π	CAPITAL PHI
242	81U	28			Ψ	CAPITAL PSI

TABLE A-1 (CONT'D)

DTE OCTAL	DRAFT KEY	HEX CODE	FDS LIST		GRAPHIC SYMBOL	DRAFT SYMBOL NAME
			NOTE	SYMBOL		
241	81L	2B			ψ	SMALL PSI
347	60U	2C			ν	SMALL NU
221	61L	2D				SP9 (SPARE DTE)
222	62L	2E				SP10 (SPARE DTE)
071	79L	33			σ	SMALL SIGMA
141	15L	38			\angle	ANGLE
046	57L	39			\sim	WAVE
161	17L	3D			\perp	PERPENDICULAR
325	75L	42				SP6 (SPARE DTE)
326	76L	43				SP7 (SPARE DTE)
270	41U	49			Λ	CAPITAL LAMBDA
266	76U	4B			.	PERIOD (DOT)
310	95U	4C			<	LESS THAN
047	77U	4D			(OPEN (LEFT) PARENTHESIS
264	36U	4E			+	PLUS
170	36L	4F				VERTICAL BAR
121	94U	50			&	AMPERSAND (AND)
175	38U	55	2,1	&	ϵ	SMALL EPSILON
215	39U	56	2,1	"	η	SMALL ETA
312	16L	5C			*	ASTERISK
050	78U	5D)	CLOSE (RIGHT) PARENTHESIS
263	56L	5E			;	SEMICOLON
167	37U	60			-	MINUS
311	93U	61			/	RIGHT SLASH
265	75U	6B			,	COMMA
142	17U	6C			%	PERCENT SIGN

TABLE A-1 (CONT'D)





DTE OCTAL	DRAFT KEY	HEX CODE	FDS	LIST	GRAPHIC SYMBOL	DRAFT SYMBOL NAME
			NOTE	SYMBOL		
200	97L	6D			—	BOTTOM HORIZONTAL LINE
307	95L	6E			>	GREATER THAN
327	93L	6F			?	QUESTION MARK
306	56U	7A			:	COLON
007	15U	7B			#	NUMBER SIGN
073	38L	7C			@	AT (EACH) SIGN
305	57U	7E			=	EQUAL SIGN
104	47L	81	3	LA	a	SMALL A
105	72L	82	3	LB	b	SMALL B
106	70L	83	3	LC	c	SMALL C
107	49L	84	3	LD	d	SMALL D
110	28L	85	3	LE	e	SMALL E
111	50L	86	3	LF	f	SMALL F
112	51L	87	3	LG	g	SMALL G
113	52L	88	3	LH	h	SMALL H
163	3L	89	3	LI	i	SMALL I
273	94L	8D				TARGET
025	58L	8E				WEDGE
207	96U	8F	2,1	#		OPEN DIAMOND
210	96L	90				CLOSED (FILLED) DIAMOND
164	53L	91	3	LJ	j	SMALL J
165	54L	92	3	LK	k	SMALL K
166	55L	93	3	LL	l	SMALL L
171	74L	94	3	LM	m	SMALL M
172	73L	95	3	LN	n	SMALL N
173	34L	96	3	LO	o	SMALL O

TABLE A-1 (CONT'D)

DTE OCTAL	DRAFT KEY	HEX. CODE	FDS LIST		GRAPHIC SYMBOL	DRAFT SYMBOL NAME
			NOTE	SYMBOL		
174	35L	97	3	LP	p	SMALL P
223	26L	98	3	LQ	q	SMALL Q
224	29L	99	3	LR	r	SMALL R
027	58U	9E			±	PLUS OR MINUS
225	48L	A2	3	LS	s	SMALL S
226	30L	A3	3	LT	t	SMALL T
227	32L	A4	3	LU	u	SMALL U
230	71L	A5	3	LV	v	SMALL V
231	27L	A6	3	LW	w	SMALL W
232	69L	A7	3	LX	x	SMALL X
233	31L	A8	3	LY	y	SMALL Y
234	68L	A9	3	LZ	z	SMALL Z
124	47U	C1			A	CAPITAL A
125	72U	C2			B	CAPITAL B
126	70U	C3			C	CAPITAL C
127	49U	C4			D	CAPITAL D
130	28U	C5			E	CAPITAL E
131	50U	C6			F	CAPITAL F
132	51U	C7			G	CAPITAL G
133	52U	C8			H	CAPITAL H
203	33U	C9			I	CAPITAL I
204	53U	D1			J	CAPITAL J
205	54U	D2			K	CAPITAL K
206	55U	D3			L	CAPITAL L
211	74U	D4			M	CAPITAL M
212	73U	D5			N	CAPITAL N
213	34U	D6			O	CAPITAL O
214	35U	D7			P	CAPITAL P

TABLE A-1 (CONT'D)

DTE OCTAL	DRAFT KEY	HEX CODE	FDS LIST		GRAPHIC SYMBOL	DRAFT SYMBOL NAME
			NOTE	SYMBOL		
243	26U	D8			Q	CAPITAL Q
244	29U	D9			R	CAPITAL R
245	48U	E2			S	CAPITAL S
246	30U	E3			T	CAPITAL T
247	32U	E4			U	CAPITAL U
250	71U	E5			V	CAPITAL V
251	27U	E6			W	CAPITAL W
252	69U	E7			X	CAPITAL X
253	31U	E8			Y	CAPITAL Y
254	68U	E9			Z	CAPITAL Z
143	14	F0			0	NUMBER ZERO
144	5	F1			1	NUMBER ONE
145	6	F2			2	NUMBER TWO
146	7	F3			3	NUMBER THREE
147	8	F4			4	NUMBER FOUR
150	9	F5			5	NUMBER FIVE
151	10	F6			6	NUMBER SIX
152	11	F7			7	NUMBER SEVEN
153	12	F8			8	NUMBER EIGHT
154	13	F9			9	NUMBER NINE

NOTES

1. TABULAR DISPLAYS.
2. PLOT DISPLAYS.
3. PLOT CHARACTER FIELD OR PLOT DISPLAY.

APPENDIX B
DRAFT SKYLAB ID ASSIGNMENTS

B.1 GENERAL

Table B-1 lists the DRAFT Skylab ID assignments.

TABLE B-1
DRAFT SKYLAB ID ASSIGNMENTS

		DESCRIPTION
MSK	0000 - 2047	DTE DISPLAYS
	6000 - 6999	STRIPCHARTS
	7000 - 7999	VARIABLE EVENTS
FCN	ALL 0000	STRIPCHARTS
	0001 - 0499	DISPLAY DEVELOPMENT
	5000 - 5999	VARIABLE EVENTS
	7000 - 9999	SKYLAB
PCL	A TO Z AS REQUIRED	
STATUS	BLANK	DEVELOPMENT OR MODIFICATION
	E	COMPLETED IN APPROVAL CYCLE
	C	COMPLETED AND APPROVED
	A	APPROVED SPEC BACKGROUND ONLY COM- plete
	I	APPROVED SPEC FDS ONLY COMPLETE
	H	COMPLETED, APPROVED, BUT HELD FOR REASON
TYPE	TAB0	TRAJECTORY TAB
	TAB1	HISTORY TAB
	TAB3	MED DISPLAY
	TAB4	LIVE ONLY
	TAB5	SPECIAL TELEMETRY DISPLAY
	PLT1	TRAJECTORY PLOT
	PLT2	TELEMETRY UNIVERSAL PLOT
	SCHR	STRIPCHART RECORDER
	LBOR	LBO RECORDER
	EV01	36 EVENT
	EV02	72 EVENT
MISSIONS	SKYLAB	SKYL1, SKYL2, SKYL3, SKYL4

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<u>DATE</u>	<u>TIME</u>		<u>ACTIVITY</u>
05-09	Completed	X	Facility received last page proofs from NASA for indexing.
05-17	Noon		Analysis Department forwards to Reprography Department last of typed index, for xeroxing of 2 copies.
05-17	04:00 PM		Reprography Department delivers typed index and two xeroxed copies to Analysis Department.
05-18	08:00 AM		Analysis Department checks the typed index and one xeroxed copy for completeness, adds text pages and forwards to Technical Coordination Department for delivery.
05-18	10:00 AM	D	Typed index, one xeroxed copy and text pages sent to NASA.

MBH:jdf
DL-7

X - Commence action
D - Date of delivery to NASA

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